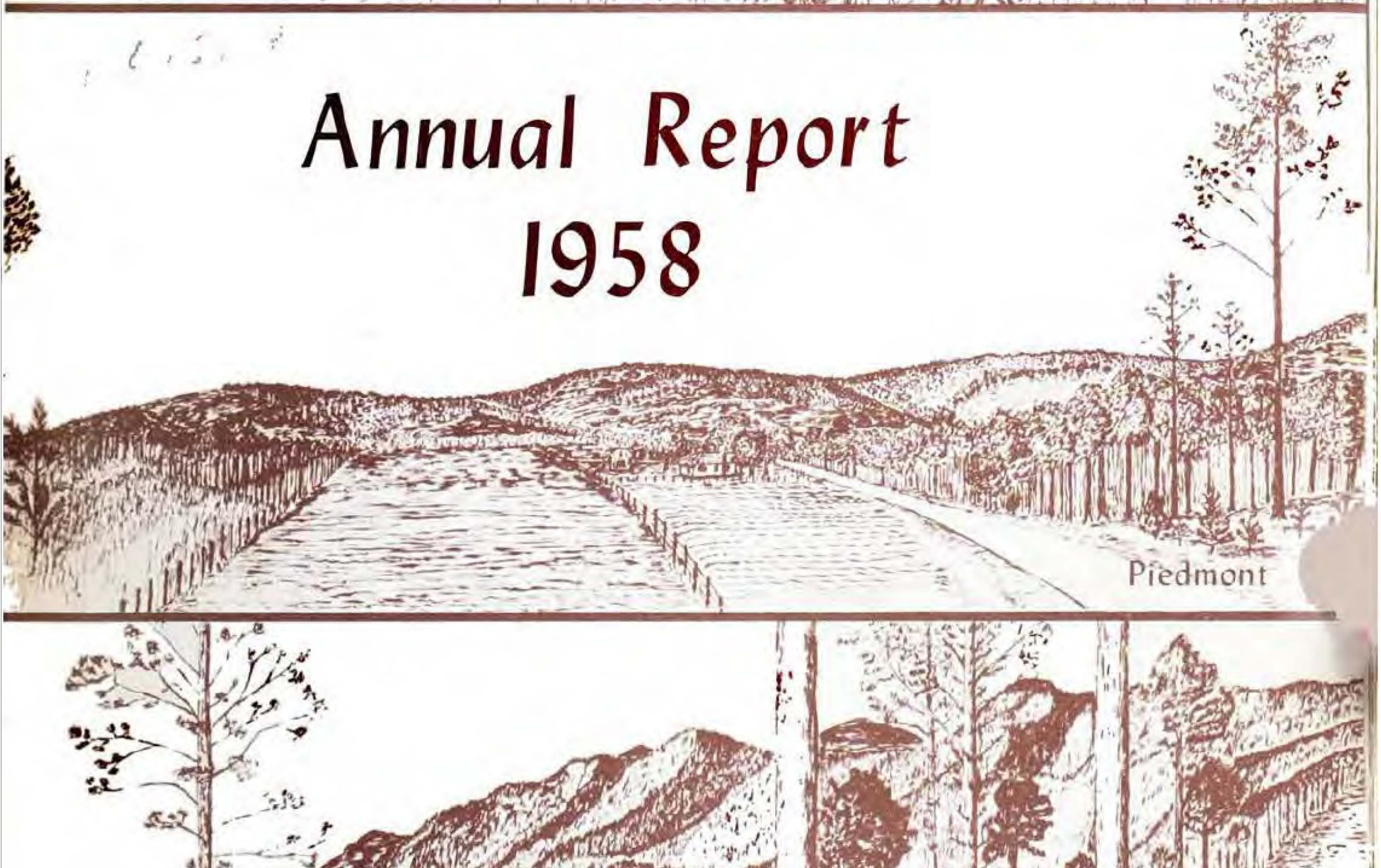
Southeastern Forest Experiment Station

Annual Report 1958



U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Southeastern Forest Experiment Station
Asheville, North Carolina

Joseph. F. Pechanec,
Director

DIVISIONS AND CENTERS

SOUTHEASTERN FOREST EXPERIMENT STATION

December 31, 1958

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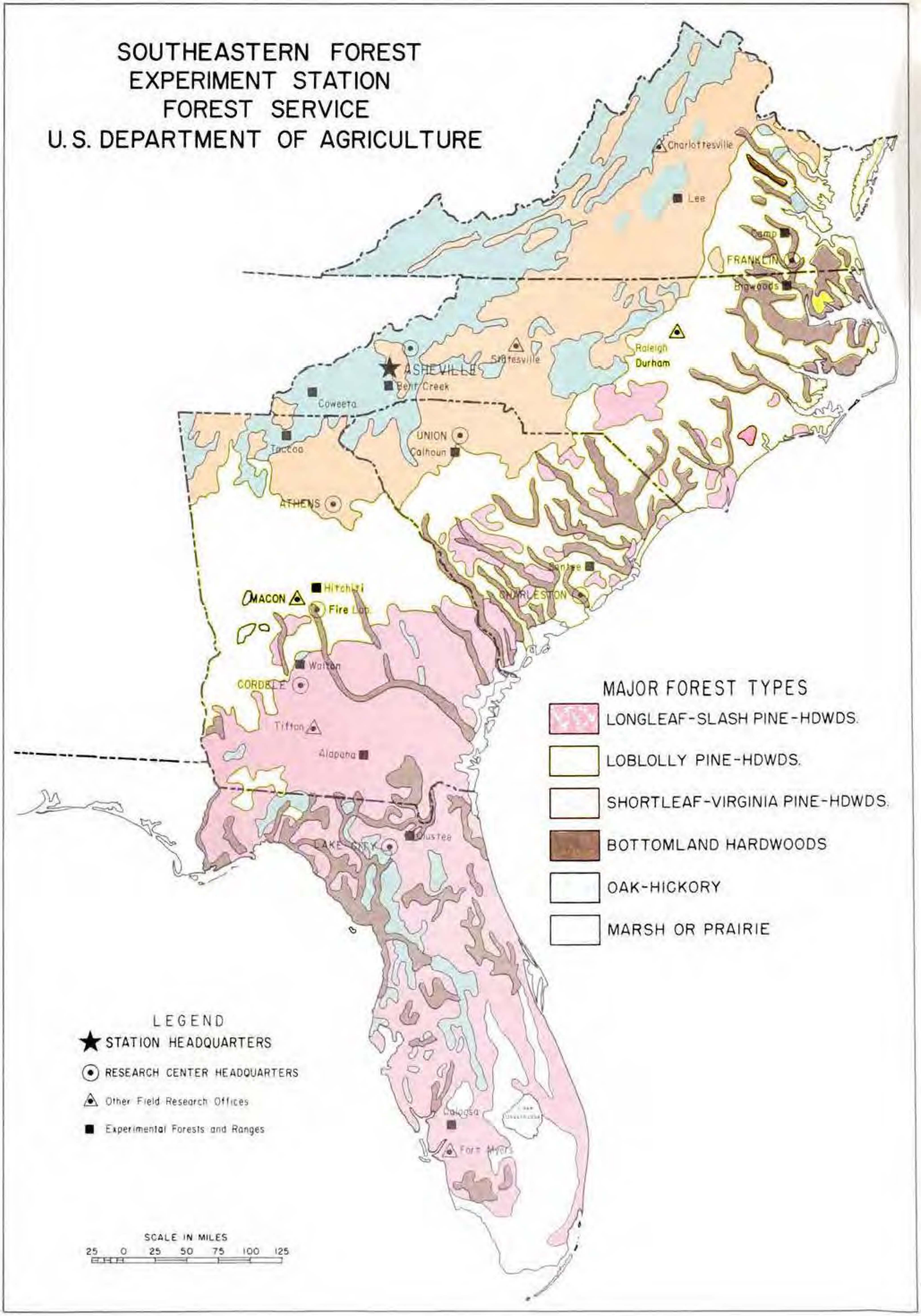
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EXPERIMENT STATION
FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE
Charlottesville
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Bigwoods
Raleigh
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Coweeta
Toccoa
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Calhoun
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MAJOR FOREST TYPES
LONGLEAF-SLASH PINE-HDWDS.
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BOTTOMLAND HARDWOODS
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Other Field Research Offices
Experimental Forests and Ranges
SCALE IN MILES
25 0 25 50 75 100 125

1958 Annual Report
Southeastern Forest Experiment Station

INTRODUCTION

The tempo of interest in forest land resources keeps rising throughout the Southeast. This is accompanied by more and more queries concerning land management for timber and naval stores production, for water, forage, wildlife, and recreation. Protecting these resources from pests and fire becomes steadily more important. Such developments have brought an encouraging increase in forest research by colleges and universities, by forest industries, and by various units of state government.

Within this climate, a dynamic federal forest research program is essential — one that can reflect changes and provide needed guides; one that can complement the enlarging research programs of others; and one that provides basic knowledge for maximum progress of its own as well as other applied research programs.

Recognition of these needs results in constant change — reoriented program, improved training for our people, and modernized research facilities. Some changes strengthen existing programs, such as those in the mountain and adjacent Piedmont hardwoods of North Carolina. Some changes, such as the seed production work and seed research in Florida and Georgia, represent an attack on problems resulting from intensified forest practices. Others fill gaps in our program — for instance, management and improvement of wetland sites in South Carolina, research in wildlife habitat, and research in Virginia pine, shortleaf pine, and upland hardwoods in the Virginia Piedmont.

We have increased our efforts in basic research — a need repeatedly emphasized. Vital expansion in fire research and the physiology of flowering and fruiting in southern pines has occurred during the last few years.

An increased number of our research people are seeking advanced training in various specialized fields. This year

we have 17 of our staff at universities throughout the country doing advanced research and study in various phases of pathology, entomology, soils, ecology, tree physiology, physics, silviculture, statistics, economics, and wood products utilization.

Some major improvements in research facilities have begun. Highly trained men and the more complex problems with which they are faced require modern equipment and other facilities. This year saw the start of construction of a fire laboratory and a seed laboratory by the State of Georgia for cooperative use, and we received authorization to build a modern office-laboratory building for our Lake City, Florida, staff.

We have seen the expansion of team research — research that applies techniques and disciplines of many sciences to the solution of the more complex problems. This group effort is now being used in seed production research, where entomologists, pathologists, and silviculturists are jointly trying to determine how to produce adequate and reliable supplies of good quality seed from seed production areas and seed orchards. The task force approach is also being used in the study of nursery production, white pine blight, and other problems.

We are also attaining depth in attack by narrowing subject-matter coverage at research centers, each center being assigned major responsibility for different problems. For example, giving leadership in soils research to the Union Center will concentrate effort and speed progress.

These steps mark progress in getting our organization, people, and facilities geared to the forest research of tomorrow.

Joseph F. Pechanec

FOREST UTILIZATION

The long campaign for utilization of hardwoods is beginning to pay off. During the past year increasing amounts of pulp were made from hardwood, new products from hardwood veneer and plywood have appeared, growth patterns and knots are being used as character markings in hardwood panelling, hardwood use in particle board is up, and charcoal markets are expanding. Utilization research by federal agencies, colleges, and state agencies has played a part in these developments, and continued cooperation promises important advances.

Georgia Wood Residue Survey

Uses for the mountains of softwood and hardwood residue that are a byproduct of wood processing plants (such as slabs from sawmills) have long been a problem. Because residue utilization has to be done on a large scale to show a profit, questions of quantity available and cost of assembling it are fundamental. The potentialities of wood residue as a basic raw material for the manufacture of varied products including wood pulp, aggregated board, and many chemical compounds prompted the Georgia Forest Research Council, aided by the Georgia Forestry Commission, the Georgia State Department of Commerce, and the Georgia State Chamber of Commerce, to contract with the Station to study the wood residue situation in Georgia. A report published in December 1958 summarizes total residue volume, volume by districts, volume by types of industry, residue disposal, reported value of residue, and the volume available for consumption. The report also contains information on potential uses of residue.

All the timber-converting and wood-using plants of Georgia were visited by trained personnel of the Georgia Forestry Commission for the purpose of obtaining annual production figures, and data on the availability, value, and methods of disposal of wood residue by type of wood-using plant. In order to determine the volume and type of residue produced in these plants, it was necessary to sample plants from each type so that we could

Figure 1.—Weighing residue to develop conversion factors for a bed-spring-frame operation in middle Georgia.

develop conversion factors, which are the ratio of the volume of residue produced to the board-feet, cubic feet, or square feet (as the case may be) of raw material used in manufacture (fig. 1).

Annual production figures based on the 1957 survey period show that approximately 891 million board-feet of pine lumber and 229 million board-feet of hardwood lumber were manufactured in Georgia by 746 reporting sawmills. Also, wood treating plants processed almost nine million cubic feet of poles, piling, and fence posts; veneer and plywood mills used about 90 million board-feet of hardwood logs and a small undetermined volume of softwood logs; planer mills and flooring plants processed 665 million board-feet of softwood lumber and 116 million board-feet of hardwood lumber; furniture factories used a million board-feet of softwood lumber, 30 million board-feet of hardwood lumber, and almost 17 million square feet of mixed plywood; and miscellaneous timber-converting and wood-using industries used 22 million

board-feet of softwood lumber, 24 million board-feet of hardwood lumber, and over 3 million square feet of plywood.

From these manufacturing processes, a total of 3,751,344 tons (green weight) of softwood residue and 1,426,499 tons (green weight) of hardwood residue was produced, with sawmills accounting for 73 percent of the total. Of this total, 4,803,437 tons of residue are available for manufacturing purposes. The report shows that 2,813,922 tons of residue are being burned at the site, left on the site, or given away. Of the million tons currently being used, the majority is sold as pulp chips (fig. 2), and the remainder is used as fuel, poultry litter, and mulch.

The Relative Efficiency of Four Stacking Methods in Air-Seasoning Southern Pine Lumber

Four methods of stacking are commonly used to air season pine lumber in Georgia—the flat pile, unit package, crib pile, and end pile. An exploratory study at a Georgia yard in 1956 indicated that drying times differ and degrade varies by methods of stacking. A study made at more than 20 yards in Georgia evaluated degrade losses and differences in drying uniformity by the above stacking methods as practiced commercially. This study brought out the need to obtain additional data on the uniformity of drying and loss by degrade and to develop information on the rate of drying. During the past year

Figure 2.—Large volumes of debarked slabs and edgings leave this Georgia sawmill daily for a slab concentration yard, where they are chipped, screened, and sold to a pulpmill for pulp chips.

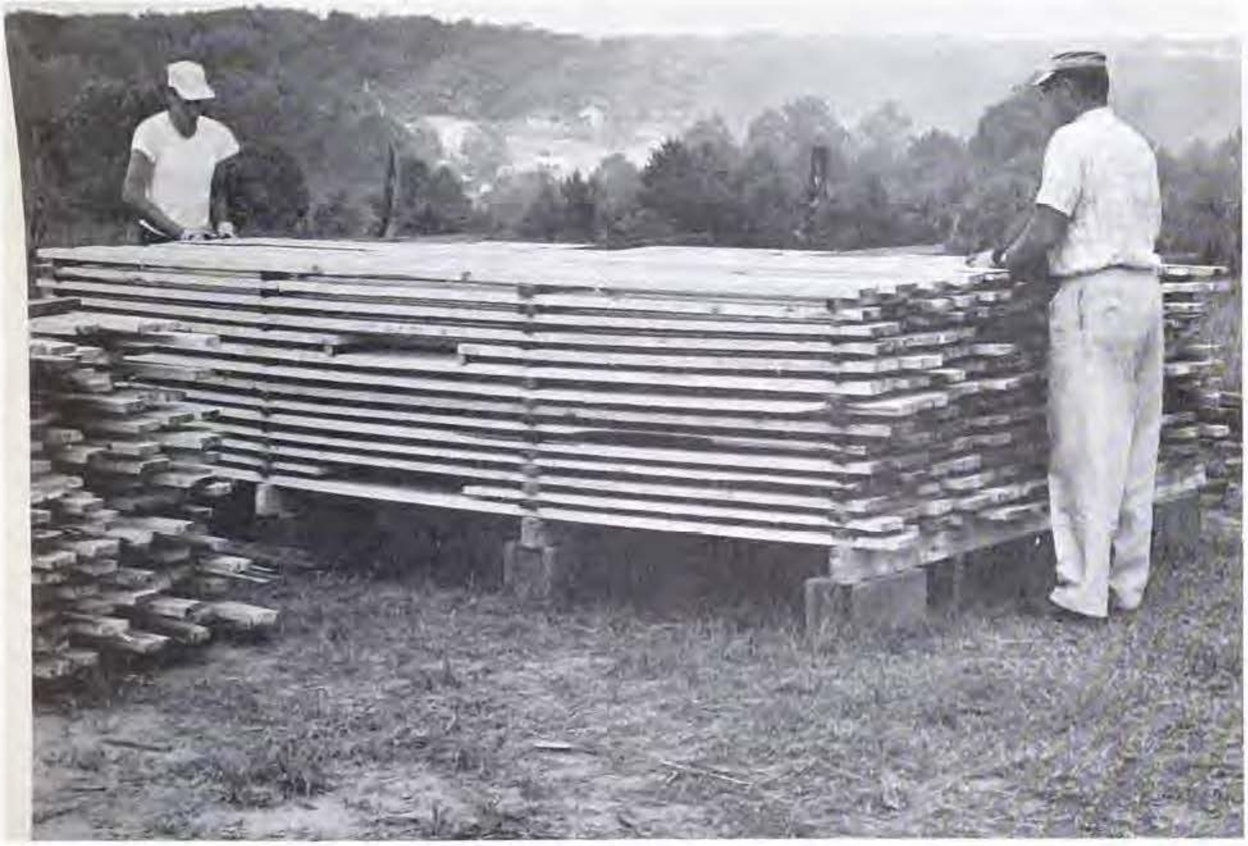


Figure 3.—Flat pile in process of construction, Hogan Brothers Lumber Company, Athens. One of several stacks used in a study of the "Relative Efficiency of Four Stacking Methods in Air-Seasoning Southern Pine Lumber." Pile was built to conform to approved stacking methods.

this information was developed.

Package-piled lumber averaged less in moisture content when torn down than did lumber stacked by other methods. Percentagewise, there were fewer boards and fewer individual moisture content determinations exceeding 19 percent in package-piled and end-piled lumber than in the other types of piles. Loss per thousand board-feet from seasoning degrade was less in package piling and end piling than in the other methods. While end-piled lumber about equals package-piled lumber in rate and uniformity of drying, end piling is not adapted to fork-lift handling. The current trend in Georgia is definitely towards mechanization, so it is fortunate that package piling rates high among the four methods most commonly used from the standpoint of drying lumber fast, uniformly, and with little loss from seasoning degrade.

These data indicate that the older, conventional method of flat piling (fig. 3) is the slowest method of drying lumber, and that crib-piled lumber does not dry satisfactorily under the laps.

Maximum Temperatures of Various Wood Elements in a House

Use of 2 x 4's made from glued 1 x 4's is on the rise in the building trade. For convenience and economy, the southern pine industry prefers the urea-resin glues for gluing these members. The glue, however, is subject to deterioration at temperatures of 120° F. and above, especially at high humidities. It is expedient, therefore, to determine the actual temperatures existing in buildings throughout the United States in order that temperature and humidity tolerances can be established for these glues.

Thermocouples were placed in a $12,000 brick veneer house being constructed in

Athens, Georgia. All thermocouples were placed on the unshaded south side of the house. August 11, 1958, was the hottest day of the month, with an air temperature of 94° F. at about 1:45 p.m. The exterior roof temperature at that time reached 148° F. The temperature between roof sheathing and rafters remained over 120° F. for about 1½ hours, while the center of the studs reached a maximum temperature of only 90° F. (fig. 4). Continued research over the country will establish useful data that can be used in house design.

Charcoal Studies

Some interesting and useful information has been obtained from the 33 charcoal burns made in the 7-cord masonry-block kiln located at Athens, Georgia. Numerous burns are necessary before many of the peculiarities of the kiln or burning variations become evident.

Researchers carried out several burns this past year using five chimneys instead of the usual three. The results were very similar to those obtained with only three chimneys. There was no decrease in coaling time and no increase in yield. The kiln generally required more supervision because more chimneys had to be sealed as they stopped smoking.

Some information has been obtained on the effect of moisture content on yield. Generally, green wood with a moisture content over 45 percent will produce extremely variable quantity yields, whereas seasoned wood will result in a relatively uniform conversion of wood to charcoal (fig. 5). Seasoned wood will generally produce about 31 percent charcoal yield (based on ovendry weight of wood) and the green wood will produce about 28 to 29 percent. Variation in yield when coaling green wood is often due to the amount of unburned wood (brands) remaining after the burn. Brand weight per burn varied from no brands to 2,800 pounds. It seems that such uncontrollable conditions as wind direction, weather, and density of wood stacking (which is related to straightness of wood) significantly influence the coaling of green wood

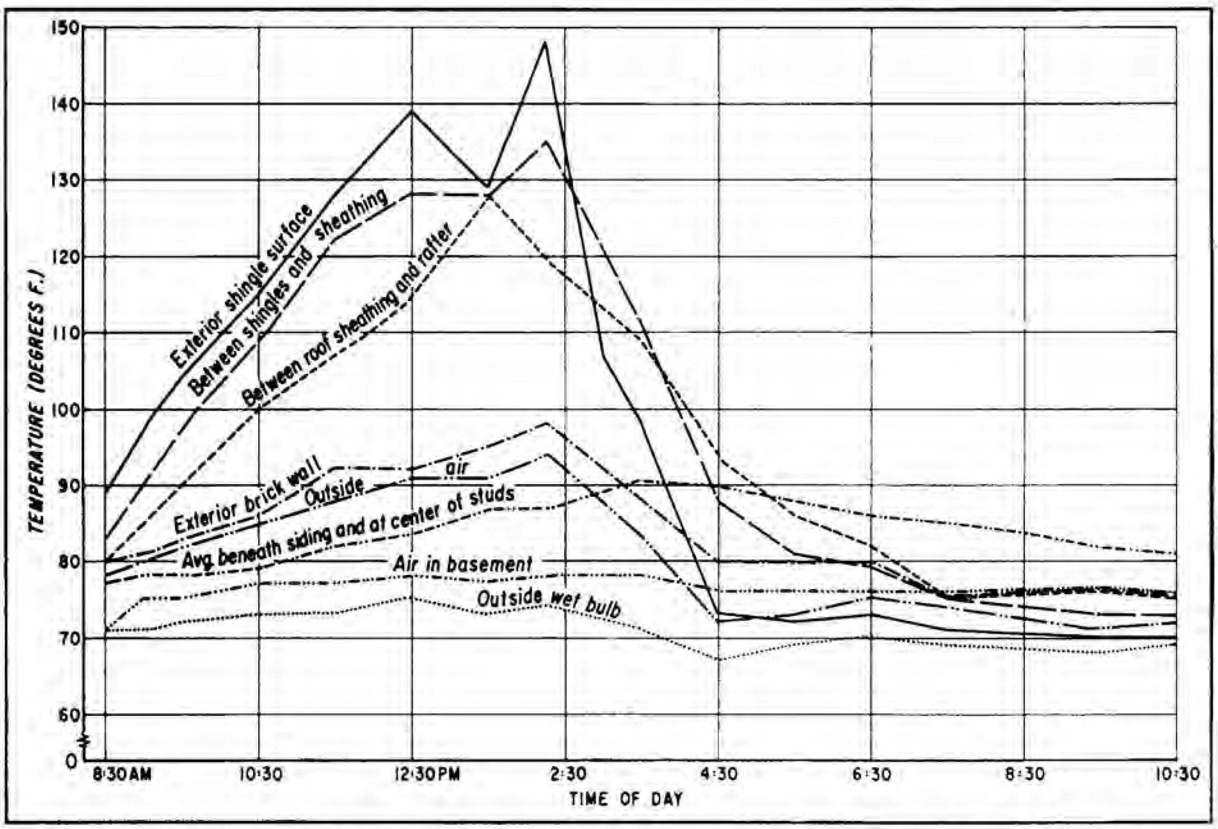


Figure 4.—Temperatures obtained at various locations in a house at Athens, Georgia, August 11, 1958.

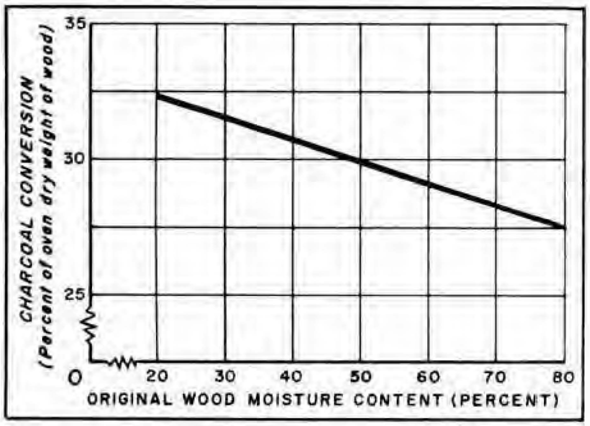


Figure 5.—Charcoal yields obtained at various wood moisture contents (7-cord charcoal kiln, Athens, Georgia).

but not dry wood. Any slightly adverse condition results in poor burning, with a large number of brands and consequently a low charcoal yield. Complete coaling of a green wood charge produces a charcoal yield as good as that from a seasoned wood load.

On a basis of experience gained from the 33 burns, we believe that the kiln front should face into the prevailing wind so that the ignition heat is blown over the kiln load. The reverse condition is true for the test kiln and probably has had a negative influence on the results.

Development of Wooden Brick

A new development in the use of low-grade hardwood lumber has taken the form of wooden brick for decorative interior partitions. During the past year, methods of unitizing this low-grade material to make a high-grade, attractive product were studied. Two simple and convenient methods for joining the brick were tested. One uses a narrow horizontal spline and the other a short vertical spline (fig. 6). Only glue is used, and the more-difficult-to-nail woods such as oak and hickory can, therefore, be used just as easily as the less dense species. Water-resistant glues and use of splines for alignment as well as for strength make the work foolproof. Because of the ease of assembly, a "do-it-yourself" market should be possible.

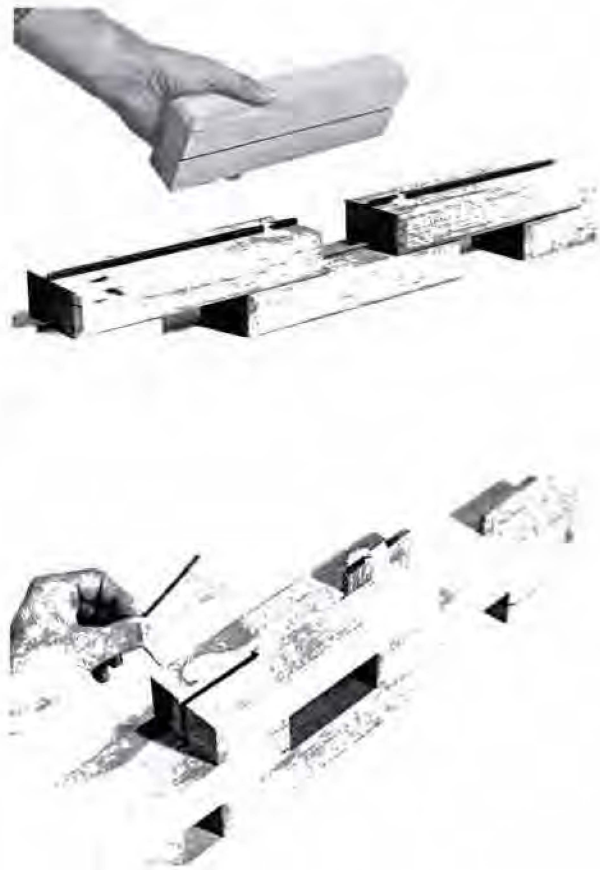


Figure 6.—Wooden brick joined by two simple methods which can be used by the homeowner.

Research in Forced-Air Drying of Lumber

Research on forced-air drying, or predrying, of southern lumber is being continued to determine the advantages of this method of seasoning, and to provide information for the design and operation of commercial predriers. One-inch pine lumber has been predried in 4 to 8 days from an average initial moisture content of 95 percent to an average final moisture content of 18 percent. A constant temperature of 80° F. and air velocities ranging from 200 to 1,000 feet per minute have been used. Little or no degrade has occurred. Under these test conditions, drying time was influenced as much by outside weather as by varying the air velocities. In order to determine the effect of air velocities and weather conditions separately, tests were made simultaneously at air velocities of 300, 550, and 800 feet per minute in three small

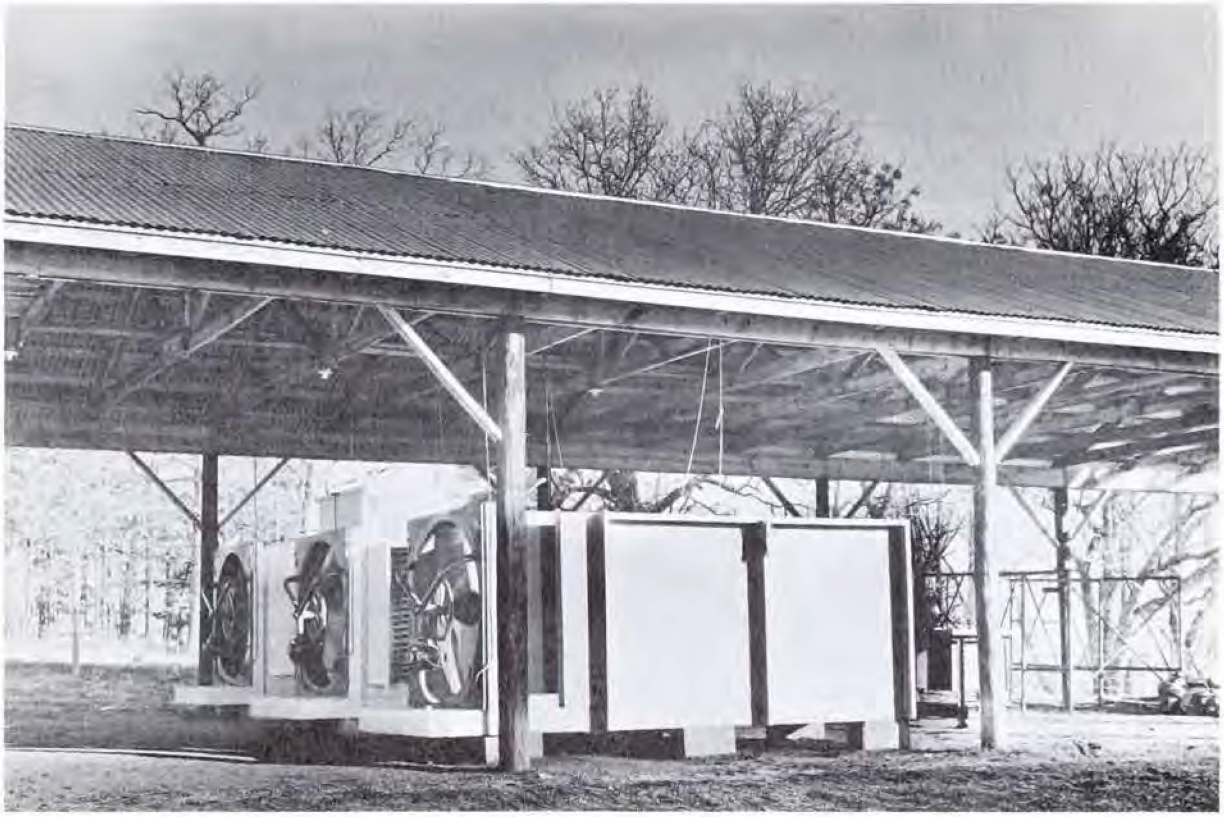


Figure 7.—Wind tunnels used for predrying tests. Several species or air velocities can be tested simultaneously so that all are subjected to the same weather conditions.

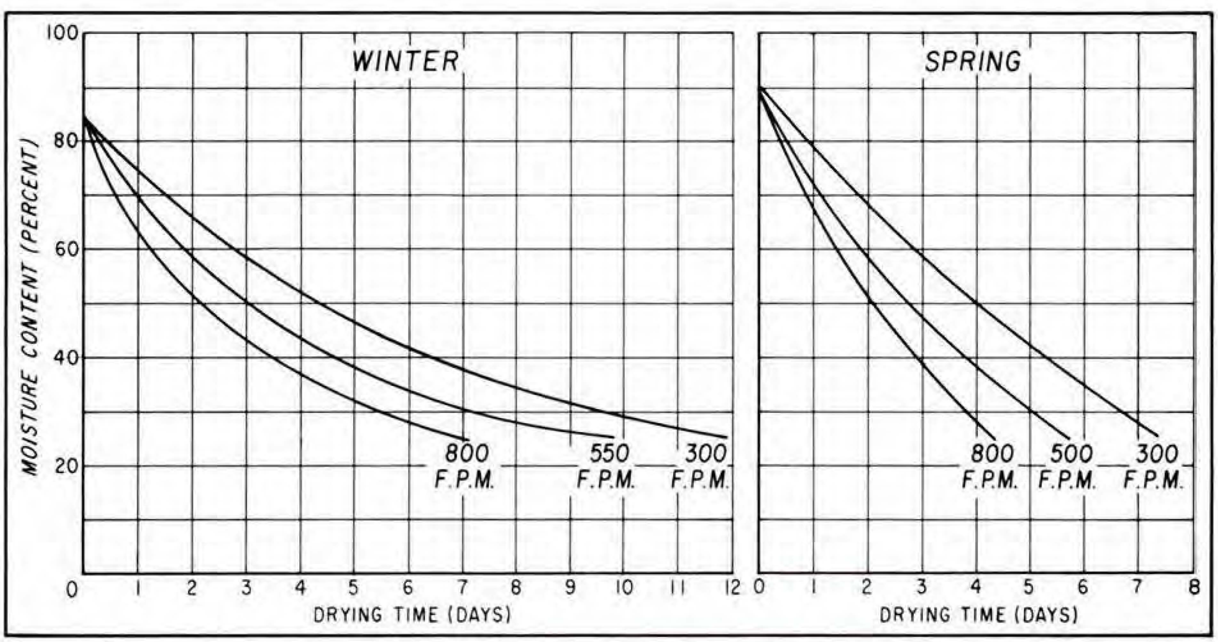


Figure 8.—Effect of air velocity on drying time of 4/4 southern pine lumber.

unheated wind tunnels during various seasons of the year (fig. 7). The results for winter drying were 12.0, 10.0, and 7.0 days respectively for the air velocities of 300, 550, and 800 f.p.m. In the spring months the drying times for the same air velocities respectively were 7.4, 5.7, and 4.3 days (fig. 8). These tests were conducted with green lumber and dried to an average moisture content of 25 percent. Wind tunnel tests and other tests conducted in a building maintained at 80° F. indicate that drying time to a moisture content of 25 percent can be reduced by 1 to 3 days with each air-velocity increase of 200 to 250 f.p.m. Tests in which fan-power requirements have been metered show, however, that the optimum air velocity is about 500 to 600 f.p.m. when the drying time and power consumption are considered together.

When a lumber dryer is operating with little or no added heat, the distance air must travel through a lumber load is important in controlling the total drying time, moisture content uniformity, and degrade from stain. Blue stain occurs readily in southern pine lumber under humid conditions at temperatures between 40° to 95° F. Results obtained in a small wind tunnel illustrate the effect of distance. Three sets of pine samples were placed 8 feet apart in a tunnel 16 feet long. Material for each set was cut from the same lumber. No heat was used, and an air velocity of 500 f.p.m. was maintained without recirculation. The drying time to a moisture content of 30 percent was 5 days for the samples at the air-entrance end, 11 days for the center samples, and 14 days for the samples at the air-exit end (fig. 9). Heavy blue stain occurred on samples located at the air-exit end of the tunnel. This points to the desirability of periodically reversing air direction and the need for caution in constructing predriers where air must travel a long distance through the load.

Satisfactory results in predrying 4/4 lumber have also been obtained by controlling the equilibrium moisture content rather than holding the temperature constant. In this method, heat is required only when outside e.m.c. is high. Heat requirements are considerably less during periods for low outside e.m.c. One-inch pine lumber green from the saw has been dried to an average moisture content of 15 percent in 4 to 6 days by means of air velocities of 500-600 f.p.m. and controlled e.m.c. between 9 and 11 percent. Lumber degrade was not significant. Temperatures reached 130° F. in tests conducted during the summer with e.m.c. controlled at 9 percent.

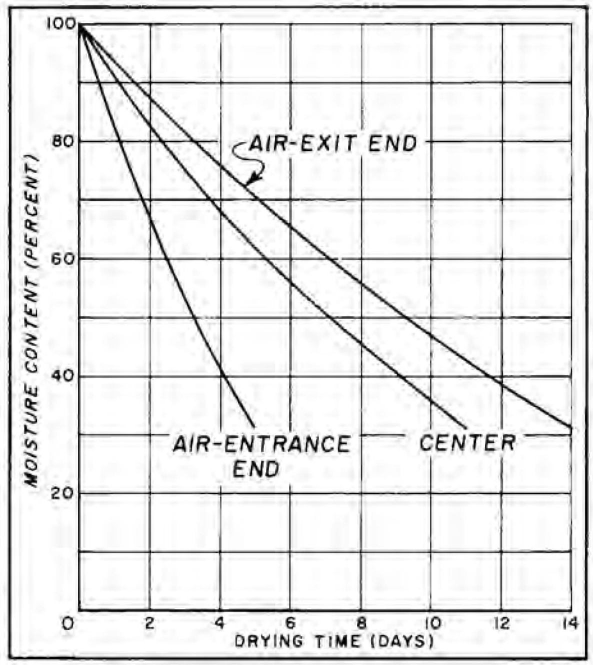


Figure 9.—Effect of length of air travel on drying time, 4/4 southern pine. Samples were placed 8 feet apart in the tunnel. Average outside air temperature was 76° F., average outside relative humidity 84 percent, and average outside e.m.c. 17.8 percent. Air velocity was 500 f.p.m. No heat was used.

Tests of other species are also being conducted. Mixed 4/4 pine, poplar, and gum have been dried with air velocities of approximately 650 f.p.m. and e.m.c. control at 10 percent. Temperatures did not exceed 120° F. Drying time for pine, poplar, and gum, green from the saw to an average moisture content of 18 percent, was 3.7, 6.9, and 8.4 days respectively. Degrade did not occur on pine or poplar, but surface checks in the heartwood of sap gum appeared on approximately 20 percent of the boards.

Studies of predrying 8/4 pine lumber are also under way. One load of 2 x 6 southern pine dimension has been dried in 7 days to average moisture content of 19 percent. Drying conditions were controlled so as to keep the maximum e.m.c. at 11 percent for the first 6 days and at 9.3 percent for the 7th day. Temperatures did not exceed 88 degrees and air velocity averaged 725 f.p.m. Degrade due to surface checking occurred on 34 per-

cent of the boards, probably because of the low e.m.c. No other degrade was noted. Further tests are scheduled at higher e.m.c. conditions.

The conclusions drawn from tests conducted during the past year indicate that e.m.c. control is desirable and should be set at approximately 11 percent for 4/4 southern pine. A maximum and minimum temperature control might also be incorporated into a forced air dryer regardless of e.m.c. to maintain temperatures within reasonable and desirable limits. The tests indicate that when e.m.c. is controlled by addition of low heat and an air velocity of approximately 500-600 f.p.m., good drying rates are obtained with a minimum of lumber degrade.

Wood Moisture Content Variation in Homes in the Southeast

The dimensional instability of wood poses a constant and perplexing problem to furniture manufacturers. Failure to manufacture furniture at the same moisture content it will have in use in the home usually results in loosening and tightening of joints, splitting, and checking.

In an effort to solve this problem, the U. S. Forest Products Laboratory made a study of the moisture content of wood in dwellings in representative cities throughout the United States. In view of the need for information about more localized conditions, the Southeastern Station in cooperation with the Southeastern Dry Kiln Club has undertaken studies in the Southeast. These studies to determine the moisture content variation in dwellings began in June of 1957 and have continued up to date.

Home moisture content determinations for one year demonstrate that the moisture content of wood varies widely by seasons of the year and in different parts of the house, as shown in figure 10. The largest variations occur during the fall and spring, and during these seasons, basements show the greatest moisture content changes. Thus, in the course of a year, wood in basements may change as much as 12 percent in the Piedmont and 9¾ percent in the mountains. Living areas showed less yearly moisture content variation, and attics the least. These variations are controlled to some extent by house construction, insulation, and heating systems, but in the best of houses, unfinished wood can

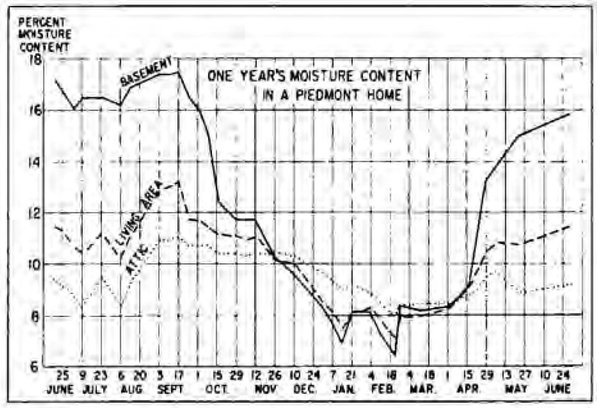


Figure 10.—Moisture contents plotted for one year in a Piedmont home show the wide variation in moisture content in the basement as compared to the more moderate changes in the living area and attic.

change in moisture content enough to cause serious damage to wood products.

The next step in this study is to ascertain the effect of finishes in retarding such changes and to develop recommendations not only on the factory moisture content of wood products but also on the methods to prevent changes that cause damage in the home.

Log and Tree Grade Studies in Southern Pine

Results from this past year's work indicate that the Interim Southern Pine Log Grades satisfactorily stratify pine logs into value groups throughout the area tested. These test areas with their respective study species are as follows: South Carolina (loblolly), Georgia (loblolly), Arkansas (shortleaf), Mississippi (loblolly), and Florida (longleaf and slash).

In comparing areas, however, it was found that the levels of value between comparable grades were somewhat different, and that these differences cannot be attributed entirely to biological differences. Extensive statistical analysis of the data has shown this to be a valid conclusion. Present indications are that these differences are at least partly caused by variations in milling practices and/or grading methods used at the various study areas. Confirmation of this supposition will involve collecting additional trees from

each of the above areas, shipping them to one mill, and conducting the sixth grade-yield study.

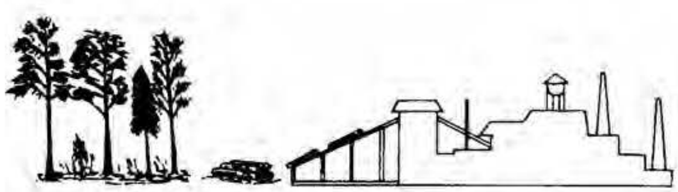
Throughout the past year, computations of pine grade yields and overruns by species and condition class have been prepared and put in use by the Southern Region of the Forest Service. This information will supplement their data used in appraisals and sales of National Forest pine lumber.

Hickory Task Force

Two Hickory Task Force Reports were published and distributed during the past year. John W. Lehman, Chief of Forest Utilization Section of TVA, prepared "Products from Hickory Bolts." This report presents information on the size, quality, and grade requirements of hickory bolts in use today. Specifications for a number of bolt products and comments on manufacturing methods are included. The other report prepared by Dean Allyn M. Herrick, of the University of Georgia School of Forestry, is entitled "Grading and Measuring Hickory Trees, Logs, and Products." Although there are no accepted standard grading systems specifically for hickory trees, logs, or bolts, Mr. Herrick has placed in his paper the grading systems developed by the U. S. Forest Service and Purdue University that appear to be suitable for hickory. Lumber grade yields have been determined for hickory trees and logs, as well as hickory product grades used by industry.

Service Activities

An intensification of service work in the form of technical assistance to forest products industries, presentation of technical papers, talks on utilization before various civic and educational groups, and conferences on research projects occupied much of the time of the Utilization Staff. This involved conferences and visits on the status of charcoal research, exploring a new process developed in Canada for the continuous carbonization and briquetting of sawdust, instruction in hardwood tree, log, and lumber grading methods and techniques, and similar work. Although our efforts have been directed largely to the solution of the more pressing problems of producers, processors, and users of forest products, the need for more basic research requires a continuing effort to ferret out basic research problems that may be recommended for study and analysis to the Forest Products Laboratory or to schools equipped and staffed to handle them.



FOREST FIRE

Construction work on the new forest fire laboratory near Macon, Georgia, is more than half finished, and the 2-story, $370,000 lab is scheduled to begin operating in 1959 (fig. 11). First of its kind in the U. S., it is a joint undertaking between the Forest Service and the State of Georgia. Funds for the building were made available by the Georgia Forest Research Council. Equipping and staffing by the Station are being made possible from recently increased Federal funds to step up forest fire research in the South. Frank Albert, Director of the Georgia Forest Research Council, deserves much credit for his part in converting the plans to reality.

Fire scientists at the lab will seek to learn more about natural laws that affect fire in the woods, and why fire responds in certain ways to weather and natural fuels. They will conduct basic research on principles relating to ignition and combustion of forest fuels, heat transfer, radiation and convection, fuel properties, and the physics and chemistry of extinguishing forest fires. They hope to develop new concepts of fire control that will be of use in the South and elsewhere.

As to men and equipment, we are in the fortunate position of gathering the best of both. The building will include a wind tunnel, water modelling room, controlled humidity and temperature chambers, combustion chamber, well equipped chemistry and physics labs, darkroom, offices, and conference rooms.

Headquarters for the Fire Research Division, under the direction of Karl W. McNasser, was moved from Asheville to Macon during the year. Research Meteorologist Dee F. Taylor, who joined the staff this year, was formerly one of the U. S. Navy's typhoon

Figure 11.—Architect's view of the new Southern Forest Fire Laboratory now under construction near Macon.

trackers and top air-weather reconnaissance officers; not the least of his achievements has been flying into the fury of 25 Pacific typhoons in winds up to 125 miles per hour and staying alive to tell about it.

To round out the staff, research engineers, research physicists, a soil scientist, and a statistician will be added to the fire group.

TESTING THE 8-100-0 METER IN THE LONGLEAF-SLASH PINE REGION

An analysis of the operation of the 8-100-0 fire danger meter in 10 key areas in 5 states from Georgia to Texas over a 2-year period has been completed. The objective was to determine how well the meter, originally developed for the predominantly hardwood forests of the Northeast, measures fire danger in the longleaf-slash pine region, where fuel types are different and there are more incendiary fires.

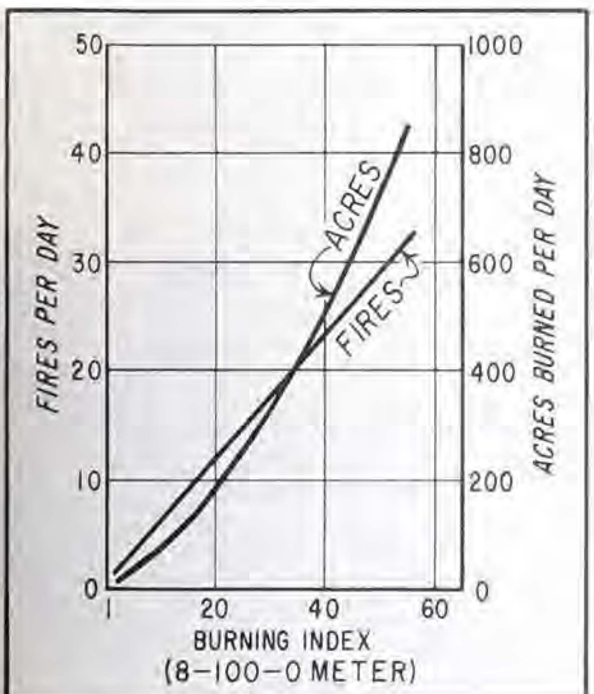


Figure 12.—Number of fires per day and acres burned per day versus numerical burning index classes on the 8-100-0 meter. Combined data for 10 key areas in five states in the longleaf-slash pine region, 1956. Class E fires not included.

In all key areas it was found that number of fires, including incendiary fires, bears an approximately straight-line relation to numerical burning index on the 8-100-0 meter. In general, as burning index doubles the number of fires also doubles. The relation for the 10 key areas combined for 1956 is shown in figure 12. Acres burned per day, which is one measure of job load, also is related to numerical burning index for all 10 key areas. This is so because more fires start, they burn faster, and are more difficult to control with worsening fire weather conditions.

From this analysis it appears that, because of the fairly regular increase in number of fires and acres burned per day with increasing burning index, the 8-100-0 meter is a reliable tool in fire control in the longleaf-slash pine region of the South.

An analysis report for each state has been prepared which presents results in more detail and suggests several applications of fire danger measurements in fire planning and evaluation of the job done.

CLASSIFICATION OF FOREST FUELS

Field work aimed at classifying forest fuels in terms of expected fire behavior was begun this year in coastal North Carolina. This new approach to fuel classification is based on thermodynamic concepts that treat fire behavior as an energy phenomenon controlled by the weather and fuel variables. To classify fuels in terms of expected fire behavior on a basis of energy and energy conversion processes requires a set of basic fuel factors such as described in the Station's 1956 Annual Report.

Study of total fuel energy was started first, since this fuel factor is of primary importance in blowup fires. Total fuel energy is the total heat content of a unit area of fuel, corrected for combustion efficiency; it is closely related to the total dry weight. In a blowup fire nearly all the fuel burns, and the total amount of fuel energy is released.

The 80,000-acre Hofmann Forest was selected for detailed analysis to develop techniques. All extensive areas of fuels that appeared different as to weight and species composition were described, and total dry weights by species were determined. Eleven types have been recognized, ranging in dry weight from about 6 tons per acre for a 3-year rough

type composed mostly of swamp cyrilla and fetterbush to about 16 tons per acre (not counting the overstory pond pine) for a very high brush type (figures 13 and 14).

It appears that the 11 tentative classes can be combined into perhaps 5 total weight (total fuel energy) classes, each of which will have a different potential for extreme fire behavior. Total fuel energy combined with the other fuel factors, including combustion period, critical burn-out time, and available fuel energy, should provide a classification of fuels covering behavior of fires of all intensities.

Figure 13.—Three-year-rough fuel type containing about 6 tons per acre of vegetation and litter.

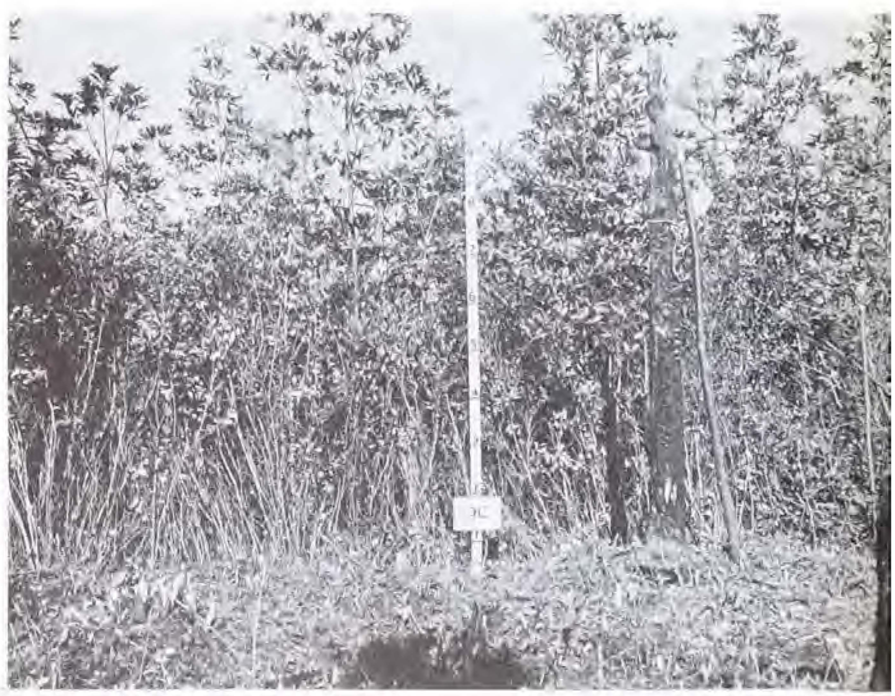


Figure 14.—Very high brush type containing about 16 tons per acre of understory vegetation and litter.

AERIAL FIRE SUPPRESSION

Research on aerial fire suppression was begun this spring in Georgia and North Carolina. Fifteen calibration drops of kaolin slurry from a TBM aerial tanker were made in natural and planted timber types in the coastal plain of Georgia and North Carolina. Timbered types have not been calibrated extensively elsewhere. In addition, the effectiveness of borate and of wet water was observed on ten drops on test fires in natural pine timber types. Equipment and techniques used were similar to those developed in the West.

In each of the four Georgia types three calibration drops were made: single 220 (only 220 gallons released); double 220 (two drops of 220 gallons released with one superimposed on the other); and single 440 (440 gallons released at one time). Over-all pattern size for all three types of drops made from altitudes between 50 and 100 feet above ground or crown canopies was about 370 feet by 75 feet in all fuel types. Patterns were fairly uniform with no gaps of low concentrations. Two typical patterns are shown in figure 15.

The amount of slurry that reached the ground in a readily discernible pattern varied with the size of load, height of drop, cover type, and wind velocity. In the open, 86 percent of the 220-gallon load fell within the pattern boundaries; 65 percent of the double 220-gallon load; and 53 percent of the 440-gallon load. The 440-gallon drop was from 10 to 35 feet greater altitude than the other two drops. Catch on the ground for 440-gallon drops averaged 41 percent under medium-density pine plantations with no understory vegetation, 37 percent under open pond pine stands with dense understory vegetation, and 34 percent for medium-dense pond pine stands with dense understory vegetation. The differences in the amounts reaching the ground in the several types, as compared to the open, represent the amounts retained on the overstory and understory vegetation. Almost complete coating of the understory vegetation and surface litter was observed where the application rate was about 0.4 gallon or more per 100 square feet. Indirect attack with 440 gallons of borate slurry retarded an average of 275 feet and extinguished 255 feet of medium-intensity headfire, in medium-dense pond pine timber with dense brush or cane understory. Estimated minimum application rates on the ground of about 0.4 and 0.5 gallon per 100 square feet were required to achieve these results. Borate drops on similar fires in very open pond pine timber with similar understory vegetation retarded and extinguished 20 feet more line but required about 0.1 gallon per 100 square feet

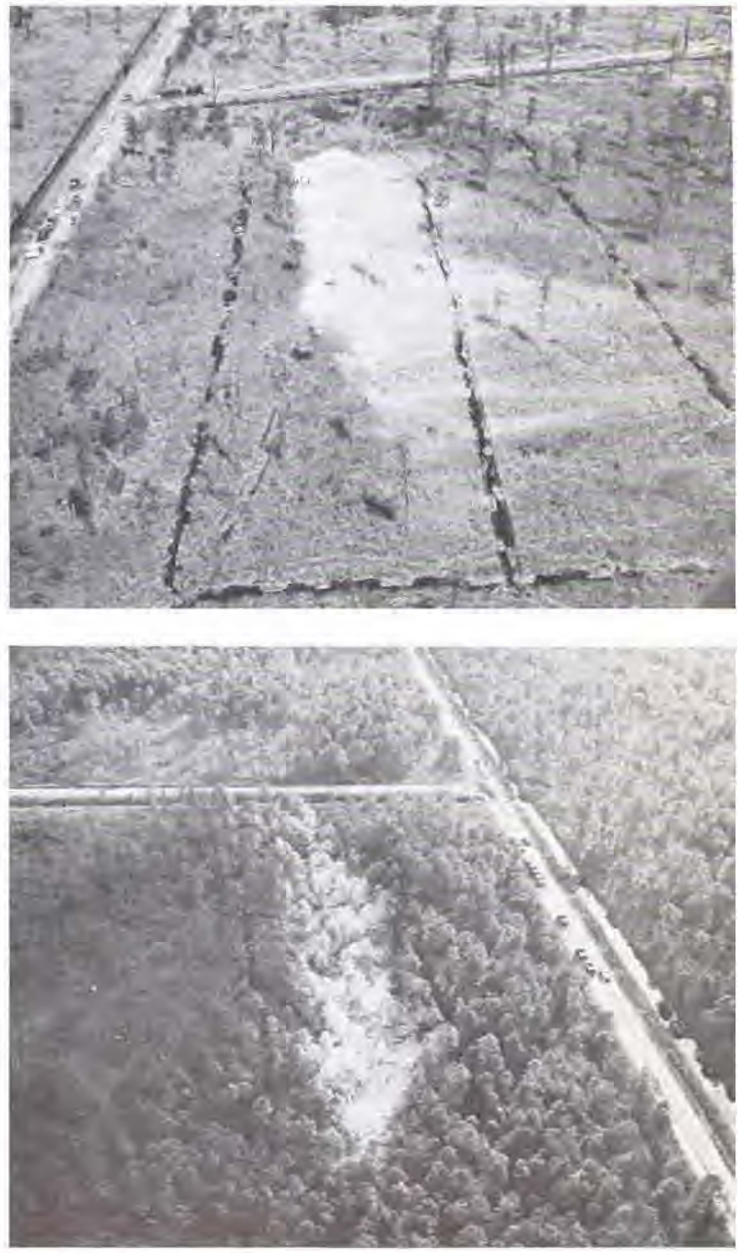


Figure 15.—Aerial views of stands, each having a heavy cane understory, after a drop of 440 gallons of kaolin slurry. Above, an open pond-pine stand. Below, a medium-dense pond-pine stand. (Photos by N. C. Division of Forestry.)

greater application rate. Observations indicate that these estimates do not apply to palmetto-gallberry fuel types, where heavier application rates apparently are needed.

Direct attack with 440 gallons of wet water on test fires achieved about the same results as indirect attack with borate in similar fuel types and under similar burning conditions. Two 220-gallon loads of wet water laid end to end extinguished a total of 400 feet of medium-intensity headfire or 200 feet on each pass in medium-density fuels.

Patterns for loads of both 220 and 440 gallons appeared to be sufficiently wide so that in no case was there a gap in the pattern which would allow fire to cross into uncoated fuel.

Time and cost were not considered in this study. However, on a basis of length of effective line built in proportion to the total length of pattern laid down the TBM shows promise as a fire suppression tool in the Southeast. Drops were placed with good accuracy and there were no difficult operational problems.

Results of these tests suggest that aircraft with both larger and smaller capacities than the TBM might profitably be tested as fire suppression tools, particularly in boggy areas, where trafficability for tractors, plows, trucks, and other standard fire-fighting equipment is poor.

MORTALITY INDICATORS FOR LONGLEAF AND SLASH PINE

In a mortality study of 480 longleaf and slash pines following the 110,000-acre Buckhead fire in March 1946 in north Florida, approximately equal proportions of large and small trees of both species died from equal amount of crown consumption. Nearly 9 trees in 10 died when more than half their needles were consumed by flame, and 4 trees in 10 succumbed when less than half their crowns were consumed. Even 100-percent needle browning caused no mortality, presumably because initial temperatures of the buds and cambium were low, about 45° F.

Height of bark char on the stem in percent of tree height also was found to be related to mortality. Approximately 9 trees in 10 died when 80 percent or more of the stem was charred, and 4 trees in 10 died when between 60 and 80 percent of the stem was blackened. Mortality was very slight where stems were charred to less than 60 percent of their lengths.

Above-normal rainfall and below-normal temperature conditions the first 3 months following the fire were favorable for survival of fire-damaged trees. However, the general drought condition that had existed in the area before the fire persisted for another year.

The mortality indicators developed in this study are limited in application to other situations having approximately similar conditions, such as air temperature (45° F.), fire (headfire), beetle (light attack), and post-fire weather (fairly normal). Air temperature was probably the most significant weather factor in reducing mortality. It is quite possible that mortality would have been double or triple had the Buckhead fire burned in an air temperature of 90° F.

METHOD FOR ESTIMATING DROUGHT CONDITIONS

Forest fire control becomes progressively more difficult during extended droughts. Aerial fuels become more flammable, firelines are hard to build and hard to hold, and fires burn with high intensity and rate of spread. A simple method for gaging drought severity would be helpful to men responsible for fire control in the South.

Work was completed this year on a preliminary method for estimating the amount of water in an inorganic forest soil profile. In operation, the observer proceeds as follows:

1. Selects one or more stations from which reliable daily precipitation and maximum and minimum temperature records are available.
2. Determines depth of tree root penetration in natural stands as an estimate of depth of soil profile to be considered.
3. Assumes water holding capacity to be 2 inches per foot of profile unless a specific figure can be obtained.
4. Selects a starting date in winter or spring when the soil profile is obviously saturated.
5. Computes the daily water balance by making daily subtractions of evapotranspiration values from the remaining available water. These values are based on mean temperature, and range from 0 to 0.32 inch. On days with rain, he adds the full amount of rain, minus the evapotranspiration value for the

day, to the water balance but not to exceed field capacity. He plots daily water balance over days.

6. During periods of low rainfall, he observes trends in the depletion curve and notes at what points fire suppression, particularly mop-up, becomes progressively more difficult because of lowered soil moisture.
7. From a series of such observations, he develops supplemental guidelines for fire-control action during drought periods.

FIRE BEHAVIOR

The Fire System Model

Fire behavior continues to be one of the main fields of study in our fire research program. The reduction of fire to its fundamental energy processes and component physical parts, and the determination of the interactions and relationships between these parts, amount to the establishment of a fire system model which represents the physical system needed to unify the various aspects of fire behavior. The term "model" is used here in an abstract sense and should not be confused with the term "scale model fire" used later.

Although not yet fully developed, a fire system model has been very effective in solving some of the more difficult problems of fire behavior and in gaining a better understanding of blowup fires. The effectiveness of such a model lies as much in the help it gives us in anticipating new fire-behavior situations and predicting new fire-behavior phenomena as in the explanations it provides for observed fire behavior. Also, the model tends to represent a physical system applying to all fires regardless of size and intensity.

There are four essential component parts in the fire system model. In its simplest form these are: (1) The earth's gravitational field, (2) a compressible fluid (i.e., the earth's atmosphere), (3) a boundary surface beneath the compressible fluid (i.e., the earth's surface), and (4) a heat source at or near the boundary surface. What is ordinarily considered a "fire," namely the flame zone where heat is being released, concerns only the fourth component of the fire system model. The combustion process as such does not enter into the fire model. It is significant only as an energy-producing agent for a certain type of heat source. Any other heat source not depending on the combustion reaction would work equally well if it were coupled by appropriate mechanisms to the other component parts of the fire system model.

The Energy Rate Number

By means of the fire system model and thermodynamic methods, certain basic fire behavior relationships can be expressed in terms of a dimensionless energy rate number. Some of these relationships were described at an earlier stage of development, in our Annual Report for 1956, in terms of power curves for the fire and the associated wind field. However, for some purposes, such as scaling problems for heat sources in a wind tunnel or in a slow-moving liquid, the energy rate number is simpler.

The energy rate number determines the over-all convective characteristics of a fire. For most ordinary fires burning in a brisk wind this number is small—usually less than 0.2 or 0.3. Such fires are of the forced convection type. If the energy rate number is greater than 1.00 the fire is a free convection type. If in addition the rate of energy output is high, such a fire is likely to develop blowup characteristics. For such fires there is usually a zone above the fire in which the energy rate number increases rapidly with height. This zone corresponds to the zone in which the wind speed decreases with height.

For a heat source in air the energy rate number N_e is

$$N_e = \frac{2gI}{T_0 c_p \rho v^3}$$

where g is the acceleration due to gravity, I the intensity of the heat source or its rate of energy output, c_p the specific heat of air at constant pressure, T_0 the air temperature at the earth's surface, ρ the air density, and v the wind speed. To maintain convective similarity between two fires of widely different intensities, such as a small-scale model fire and a full-scale fire, it is essential that the energy rate number be the same for both fires. If they are burning in the same atmosphere, that is, if T_0 and ρ are the same for both fires, then the requirement for equal energy rate numbers leads to the scaling equation

$$\frac{v_m}{v_f} = \left(\frac{I_m}{I_f}\right)^{1/3}$$

Although the subscripts m and f refer to a model fire and full-scale fire respectively, the scaling equation holds for any two fires

with the same energy rate number.

For an incompressible liquid the equation for the energy rate number is

$$N_e = \frac{2\,g\,I}{k\,c_p\,\rho\,v^3}$$

in which k is the reciprocal of the temperature coefficient for volume expansion. This equation is identical to that for a heat source in air except that k replaces T_o. If a full-scale fire is to be represented by a heat source in a slow-moving liquid, the scaling equation becomes

$$\frac{v_m}{v_f} = \left[\frac{(T_o)_f}{k_m}\;\frac{(c_p)_f}{(c_p)_m}\;\frac{\rho_f}{\rho_m}\;\frac{I_m}{I_f}\right]^{1/3}$$

This equation gives a much smaller value for the $\frac{v_m}{v_f}$ ratio than for a heat source of the same intensity in air.

The Weightless Gas Equivalent of a Heat Source

One of the most instructive forms of the fire system model, especially with respect to blowup fires, can be obtained by replacing the fourth component of the fire system model (the heat source) with an energy source that does not involve heat. This energy source can be either a hypothetical gas of zero density, or a real gas of low density such as helium, which is supplied at a rate which can be accurately calculated in terms of an equivalent heat source of a given intensity. At the normal barometric pressure of sea level, about 1,100 cubic feet of weightless gas (or about 1,300 cubic feet of helium) per second per foot of fire front would be equivalent to a heat source of 1,000 Btu per second per foot. This would be considered a fairly hot fire with flames about 9 feet high. For a major fire of 20,000 Btu per second per foot with flames 60 to 100 feet in height, the total rate of supply of the weightless gas equivalent would have to be 2.3×10^7 cubic feet per second for each 2 miles of fire front. This would be roughly one cubic mile of weightless gas every 100 minutes. The helium equivalent would be about one cubic mile of helium every 85 minutes — a rate difficult to comprehend.

One of the main contributions resulting from substituting in the fire system model either the hypothetical weightless gas or the helium equivalent is the insight it gives into the fundamental nature of fire behavior. It indicates that the convective phenomena which dominate extreme fire behavior can be duplicated by an energy source which involves neither combustion nor even heat as such. For example, the turbulent motions in the convection column over a high-intensity fire, as well as the whirlwinds and long-distance spotting, should remain unchanged if the fire were taken away and large quantities of helium gas released at the appropriate rate over the previously burning area. However, for the helium source the "embers" would be cold. The buoyancy of hot gases resulting from the combustion process represents potential energy. The same is true of either helium or a weightless gas which has buoyancy at ordinary temperatures. In either case the potential energy converts to kinetic energy as the gases travel upwards. Violent convective phenomena are basically a function of the buoyancy of the convection column gases rather than the process such as combustion, by which the buoyancy is produced. The relationship between combustion and fire behavior thus appears to be of an incidental nature rather than a direct cause and effect. This point of view could have a pronounced effect on fire behavior research.

WINDS-ALOFT MONITORING STATION ESTABLISHED

The relation between certain types of wind profiles and extreme fire behavior has been reasonably well established through past research by the Division. Eventually we hope to be able to predict such profiles hours or days in advance. Until then, however, we can obtain some degree of warning by taking soundings of the winds aloft in high hazard areas on days when fire danger is building up.

The first winds-aloft monitoring station was established this fall near New Bern, North Carolina, in cooperation with the North Carolina Division of Forestry (fig. 16). Balloons are released at specified times according to the buildup and burning indexes on the 8-100-0 meter. Readings with a theodolite are taken periodically to a height of about 6,000 feet and the wind profile plotted. A double theodolite installation to give precise measurement of the speed of upper winds has been set up at Dry Branch, Georgia, for research purposes.

Figure 16.—Tracking a pilot balloon with a theodolite to chart wind speed and direction aloft. Wind profiles so obtained can give warning of extreme fire danger when fuels are dry.

The fire behavior that can be expected for wind profile types can be estimated by reference to an interim report, "Key-Vertical Wind Profiles and Associated Fire Behavior in Flat Country," prepared by the Division. Expected fire behavior can then be carried into the action phase on a going fire or used in presuppression planning.

UNIFIED FIRE DANGER SYSTEM

During the past 20 years the use of fire danger measurement has progressed far beyond the testing stage and is today universally recognized as a key tool in fire control management. Unfortunately, there is no uniformity in measurement techniques or application. Though the need for precise fire danger information is nationwide, the factors recognized, the method of measurement, and their integration in a scale of fire danger vary widely in the different regions of the country. Since combustion and fire behavior follow the same natural laws everywhere, the multiple variation in existing fire danger systems serves to confuse rather than to clarify.

In response to a long-felt need, representatives from Fire Research, Fire Control, and State and Private Forestry met in Washington last January to explore the possibility of developing a national fire danger measuring system. The committee members unanimously agreed that a unified system based on weather variables for standardized fuels was entirely feasible, and recommended a research project be set up. In line with the committee recommendation, a staff position was created in the Washington Office Division of Fire Research. John Keetch was assigned to head up the project, with field headquarters at Asheville, N. C.

TRENDS IN NUMBER OF FIRES AND ACRES BURNED IN THE NORTHEAST

Forest fire and fire danger analyses have been prepared annually since 1943 for each of 13 Northeastern states from Kentucky northeastward to Maine. A composite tabulation for all states for the period (figures 17 and 18) provides a revealing summary of the relative progress in fire prevention effectiveness and suppression accomplishment on state and private protected land.

In figure 17, the total number of fires, the burning index in thousands of units, and the number of fires per thousand units, are

plotted by years. The top graph indicates that there has been no definite trend in total number of fires during the period. But the center graph shows that burning conditions have decidedly worsened. When occurrence rates, i.e., number of fires per thousand units, are plotted as in the lower graph, there is a pronounced downward trend. This trend throughout most of the period means that substantially fewer fires have occurred from year to year for similar amounts of fire weather. Because there has undoubtedly been an increase in potential human risk during the analysis period, we can safely assume that prevention efforts have been highly successful.

The relative progress in reducing the area burned by forest fires has also been appraised by plotting 3-year moving averages of the number of acres burned per million acres protected per thousand units of burning index (fig. 18). The burned-area-rate trend of the lower curve in the figure indicates a decided and fairly persistent improvement in suppression accomplishment when Class E fires — 300 acres or larger — are excluded. Unfortunately, this does not hold true when all fires are considered (upper curve).

Fire control men are aware that a relatively few fires cause a relatively large percent of total acres burned. This fact is brought out by comparing total number of fires and acres burned with Class E fires and acres. During the 15-year period, somewhat more than 208 thousand fires burned almost 5 million acres. But 2,400 Class E fires (1.2 percent) burned almost 2¾ million acres (55 percent). This emphasizes the fact that sustained improvement in fire suppression is contingent upon designing fire control organizations better geared to handling emergency conditions.

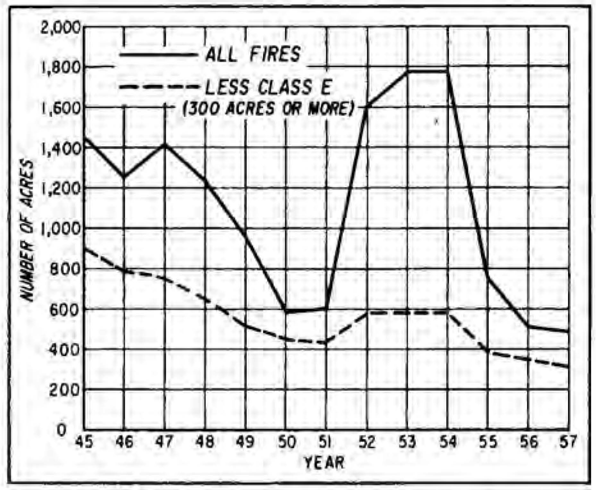


Figure 18.—Burned area rate (number of acres burned per 1,000 units of burning index per million acres protected) for 13 Northeastern States, 3-year moving average, 1943-57.

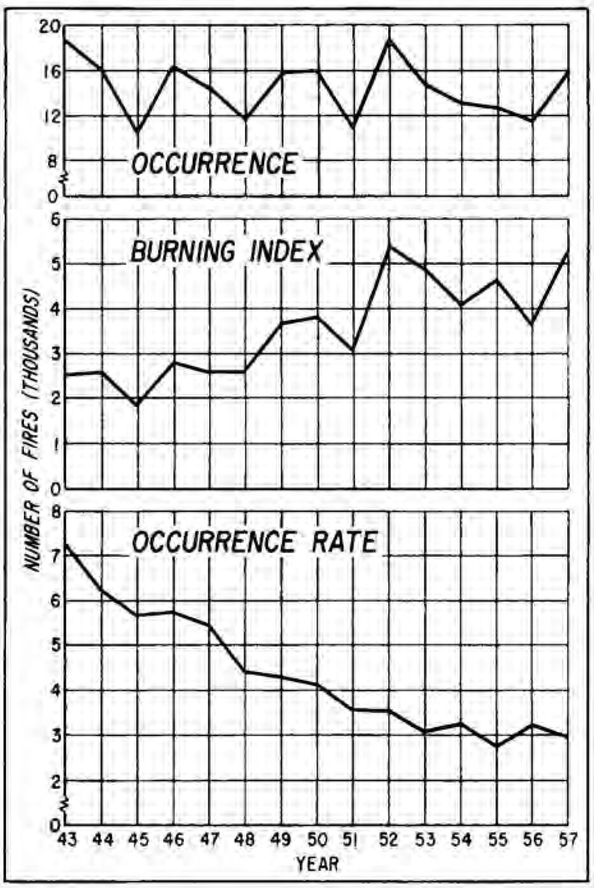


Figure 17.—Occurrence, burning index, and occurrence rate (number of fires per 1,000 units of burning index) for 13 Northeastern States, by years, 1943-57.

WATERSHED MANAGEMENT

Station research in management of forest lands for water production and related purposes has been under way about 25 years at the Coweeta Hydrologic Laboratory located near Franklin, N. C., and on a more limited scale since 1947 on the Calhoun Experimental Forest near Union, S. C. Although the Coweeta experiments are widely known for mountain catchments to test streamflow response from cover alteration and other land treatment, the research there is being geared increasingly to basic plot-laboratory studies of watershed processes, particularly those governing evapotranspiration and other important water losses. Activities during the past year reflect this shift in emphasis, with greater effort on fundamental studies of soil-moisture-plant relationships.

Related to these activities was progress on studies of the physiology of water use by forest trees, long under consideration and much needed. Toward the end of the year, arrangements were made for starting a study on techniques for measuring moisture tensions in forest trees; also a related study to ascertain whether such values are possible indicators of water use requirements. This work will be conducted at Duke University by John Hewlett of the Coweeta staff. Such research holds many of the answers needed in assessing the consumptive demands of various cover types as well as other factors affecting water loss and yield.

Forest Soils Work at Union

With the present emphasis on fundamentals, project work in forest soils has increased at all the Station's research units. Since this work contributes to most functional lines of research, it was thought desirable to concentrate Station efforts at one place for greater efficiency. Accordingly, during this past year the activities of our Union Research Center have been reoriented to provide leadership in soils research, advice and assistance to all centers and divisions on forest soils problems, and training opportunities for other research workers.

Relations Between Timber and Soil Moisture in the Piedmont

A lot of water is removed from the soil as vegetation transpires. During the long warm summers in the Southeast, this process is so active that most of the rainfall is lost to the atmosphere before it can penetrate a foot or two of soil. After the first flush of spring growth, much of the soil moisture in the root zone may therefore be reduced to the wilting point by direct evaporation and transpiration, and by the latter process at greater depths.

If vegetation is shallow-rooted, as are some grasses, the dry zone may not extend deeper than the surface foot or foot-and-a-half, with ample moisture in the lower soil layers. However, in timber stands, even under young pines only 10 or 12 years old, the roots will often use all available soil moisture to a depth of more than eight feet. Since it is impractical, at least so far, to turn precipitation on and off, other means must be sought to get maximum benefit from that which falls. One way may be to thin timber stands so that there are fewer trees to use the available water. This may make more water available for streamflow or groundwater storage; and with extra sunlight, the crop trees should increase their growth.

To see just how soil moisture is influenced by stand density, part of a 17-year-old loblolly pine plantation on the Calhoun Experimental Forest near Union, South Carolina, was thinned in 1957 so that half the basal area was removed. Moisture was then sampled on thinned and unthinned portions of the stand by driving a 1-inch-diameter tube into the soil and extracting and weighing the cores for moisture content.

In the surface foot of soil, evapotranspiration removed water quite rapidly under both stand conditions. Depletion occurred, however, at a much slower rate in the thinned stand, and this layer of soil contained available moisture for tree or seedling growth 15 days after the moisture in the same soil zone under the unthinned stand had reached the

wilting point. Moreover, the thinned stand contained an inch more water in the surface 4 feet of soil after 30 days of drying (fig. 19).

During the dormant season following thinning, winter rains recharged soil moisture to a depth of 8 feet under the thinned plantation, whereas complete recharge did not occur below the 4-foot level in the unthinned stand. While these doubtless are not maximum differences in moisture content for thinned and unthinned Piedmont stands, they illustrate important relationships affecting water yields, stormflow, and tree regeneration and growth.

The difference in moisture levels on the Calhoun plots has persisted for two growing seasons. Although it is not known how long these differences will continue, it can be surmised that evapotranspiration losses from the two plots will soon equalize as roots and crowns of the thinned trees expand.

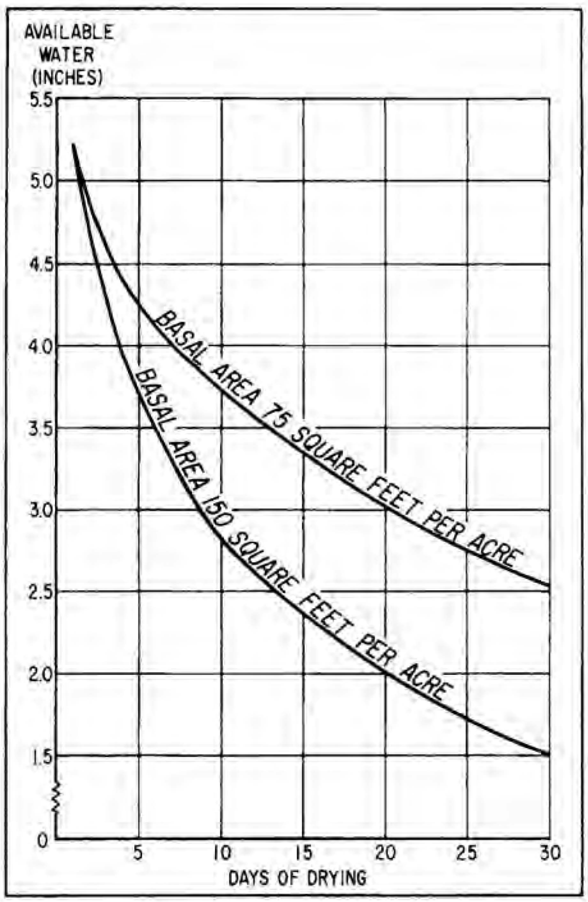


Figure 19.—Moisture depletion from the upper 48 inches of Piedmont soil in a thinned and an unthinned loblolly pine plantation.

Soil Moisture Sampling by Neutron Method

One of the continuing difficulties in studies such as the Calhoun plantation plots described above concerns measurement techniques in collecting sufficient data so that small differences between plots can be detected and effect of treatment reliably assessed. Gravimetric sampling, which necessitates driving a tube to a depth of 8 feet fifty times or more every time samples have to be collected, and processing literally hundreds of these samples to get the answers, seems impractical in our studies; and experience shows that unless large numbers of them are taken, reliable answers cannot be had. This long-standing problem of accurately measuring soil moisture quantitatively and its fluctuations on plots or other unit areas still troubles technicians and is everywhere handicapping watershed management research. One possible solution to this problem is use of the neutron-scattering method for measuring soil moisture. This procedure, now under test at the Coweeta Hydrologic Laboratory, shows considerable promise as a means of detecting quite small changes in soil moisture content and will be tested soon under Piedmont conditions.

Watershed Cover and Water Yields

Whether changes in cover type appreciably affect water yield is a commonly asked question. To afford some answers, a carefully controlled experiment utilizing 5 treated watersheds is now under way at the Coweeta Hydrologic Laboratory to get some gross measures of the differential effects of cover type on water yield for actual drainage units.

Essentially, the conception or premise is that one type of plant cover may consume more or less water than another and hence the right manipulation of cover will pay off in greater streamflow. Converting watershed cover from trees to grass or perhaps low-growing shrubs is one prescription which will seem a logical course of action where water supplies become critical and other sources or alternatives are not available. But whether this or other changes in cover type will produce more water for specific situations of terrain, soil, and climate is highly uncertain and unpredictable at this stage.

Of perhaps more direct implication for foresters are the huge tree-planting programs now under way in the Southeast, and the speculation these programs engender as to probable watershed influence. Pines are commonly being planted to convert inferior hardwoods to stands of commercially valuable trees. Unquestionably, these plantings are creating major watershed benefits, particularly where better cover is needed in sparse stands and open areas. But foresters and other conservationists are concerned whether the shift to pine in the long run may unfavorably affect soils and site quality, and whether the pines will make greater demand on water supplies.

Although hardwoods are commonly thought to use more water than pines, there is not much evidence one way or the other. The Coweeta study, started in 1955, will compare water-yield responses for a series of calibrated watershed units averaging about 30 acres in size and representing: (1) natural hardwood forest, (2) white pine on north and south exposures, (3) perennial grass, and (4) shrub cover. One of the units now planted wholly to pine is Watershed 17, which formerly was clear cut and then cut back annually in a classical, well-known experiment; and the other white pine unit (southerly exposure) was cleared of hardwood forest and planted in 1956 (fig. 20).

Figure 20.—Planting white pine seedlings on a clear-cut Coweeta watershed in an experiment comparing water yield from several cover types.

Figure 21.—Test planting of white pine on clear-cut Coweeta Watershed 17. Planted 1945.

The conversion from forest to grass is now in progress on the unit scheduled for this treatment. Plans for converting a fourth drainage from high forest to shrub cover are under consideration, though contingent on further study as to species, maintenance requirements, and the like. All the drainages have been gaged for about 20 years prior to type conversion; and plans call for long-term observation of the pine watersheds to fully document soil-site and other changes.

Of special interest to visitors are the 1945 test plantings of white pine on several small plots on the north-facing Watershed 17 (fig. 21). The aim was to see how well the pines would do on these sites. The plantings, now in their 14th year, are growing vigorously, with many of the trees 30 feet or more in height. The dense canopy has long since closed and eliminated hardwood sprouts and understory vegetation; it has blanketed the steep slope with a deep layer of protective pine litter (fig. 22).

Comparison with nearby hardwood forest like the original stand occupying this site shows somewhat less incorporation of humus with mineral soil under the pines but a greater total depth of litter plus humus. Infiltration tests and other observations indicate no impairment whatever in capacity of these soils to take in and store water; and indeed the soil under pine, as under the original hardwoods, can wholly absorb any Coweeta rainfall of record without causing overland flow.

Figure 22.—Forest floor under 14-year-old white pine. This is the interior of the test planting shown in figure 21.

RANGE MANAGEMENT

Of special interest are new game habitat management studies, long sought by forestry and wildlife interests in the Southeast. To head up the new activity, Dr. Thomas Ripley, a biologist with degrees in wildlife management from the University of Massachusetts and Virginia Polytechnic Institute, and research experience in state programs, reported for duty as Station Staff Biologist in July. First effort has gone into an appraisal of game habitat research needs and regional study priorities, with particular emphasis on problems in (1) evaluating the forest and animal responses from timber cultural practices and (2) managing badly overbrowsed deer ranges. To strengthen animal biology phases of the research, Frank Johnson, who for many years has coordinated Federal-Aid work for the State of West Virginia, has been assigned to the Station by the Fish and Wildlife Service for cooperative work, with headquarters in Asheville. He reported for the new assignment at the close of the year.

Cooperative range research to help landowners make best use of forage in the piney woods country continued at Tifton, Georgia, and Fort Myers, Florida, with notable progress at both locations.

The changing situation in woods grazing in south Georgia and adjacent longleaf-slash pine country received special review and attention during the year to guide future range studies at Tifton. Here, some 16 years of productive research, undertaken cooperatively with the Georgia Coastal Plain Station and the Agricultural Research Service, has developed practical methods of using native forest range effectively in conjunction with feed supplements. However, a new stock law in Georgia, declining interest in woods grazing by many large land holders, and other factors are operating to greatly reduce woods grazing in the old pattern. But at the same time there are many new developments — the trend toward cut-and-plant forestry, even-aged management of timber stands, greater use of large-scale site preparation for longleaf planting, and the like — which can greatly enhance opportunities for forage production in southern woodlands.

Probably the best research studies for serving the needs of timberland owners under the changing situation are those that demonstrate ways of grazing cattle in young slash pine stands, both natural and planted. Accordingly, the Tifton program calls for greater emphasis on studies of grazing impact on slash-pine stands, and how to minimize tree damage; forage production and responses to site preparation, fertilization and other cultural practices in managing pine plantations; and related research to enable more profitable dual-use of forest holdings.

An important event furthering range and other forest research efforts in the South was a 1-week symposium devoted to methods and techniques for measuring forage and other understory vegetation. Jointly sponsored by the Southeastern and Southern Forest Experiment Stations, the symposium was attended by some 60 foresters, range specialists, and wildlife biologists.

Another newsworthy development was the start of work at Duke University by J. B. Hilmon, of the Fort Myers staff, on the fundamental biology and environmental requirements of saw-palmetto. This widespread undesirable is a major problem in fire protection, and its control is also of great importance to timber and beef producers.

Integrating Timber and Cattle Production on Intensively Managed Pastures

How to raise trees and cattle together profitably on piney woods range poses some management difficulties which concern many landowners in the Southeast. Key problems include (1) getting a greater output of quality forage yearlong; and (2) successfully regenerating slash pine stands with minimum damage to reproduction from prescribed burning and grazing. Consequently, on the Alapaha Experimental Range near Tifton in Berrien County, Georgia, a study was commenced in 1954 in cooperation with the Georgia Coastal Plain Experiment Station and the Agricultural Research Service. The

idea is to establish improved stands by means of fertilizer in slash pine plantations and to graze cattle while the trees grow to marketable size.

During the winter of 1954-55, slash pine trees were planted (two spacings) and 4 common pasture grasses (carpet, coastal bermuda, Pensacola bahia, and dallisgrass) on 2-acre test units; all units were clean-cultivated, fertilized, and limed.

Cattle were turned into the plantations on May 1, 1956, when trees were from 1 to 4 feet tall. Grazing damage was immediately evident, and by the end of May was prevalent in all plantations despite an abundance of high-quality, palatable forage. At this time elongating terminal and lateral buds were injured and lateral branches were broken. Subsequently, during the summer, browsing of pine foliage and mechanical damage was most pronounced for trees 2 to 4 feet in height. By November, foliage losses exceeded 50 percent on most trees, and 20 percent were dead. Injury to foliage and branches of trees 5 feet and higher was not excessive, however.

This phase of the Alapaha study demonstrated some of the pitfalls in trying to raise trees and cattle together when animals are confined to small areas of improved forage.

A new approach, drawing on leads from the first effort, was launched in 1957. Since clean cultivation in two of the earlier plantations apparently increased height growth of planted trees, and considerable damage can be expected while trees are small, frequent cultivation was prescribed as a means of increasing growth rate until trees reach a size that can tolerate grazing before we attempt to re-establish the pasture grasses. Accordingly, all plantations were completely renovated and new pine seedlings planted in January 1957 at the spacings used before, namely, 12 x 12 feet and 20 x 20 feet; and the trees were cultivated during the 1957 and 1958 growing seasons.

This treatment obviously has been effective in speeding growth of the slash pine. Cultivated trees averaged 22 inches in height after the first year and 61 inches at the end of the second (1958) growing season. Comparatively, this was about twice the height

Figure 23.—Clean-cultivated slash pine plantation used to test the effectiveness of fertilizer applications on height growth, Alapaha Experimental Forest, Ga.

growth made by uncultivated trees in the initial plantings in 1955.

Study plans call for cultivating the plantations again in 1959, for applying fertilizer and planting the pasture grasses in February 1960, and for turning the cattle in the following June. By that time, tree height should average more than 8 feet, new shoot growth will have hardened off, and forage species will have made considerable growth.

Effect of fertilizer is also being studied in an auxiliary Alapaha experiment started in 1957 (fig. 23). Some 1,150 slash pines spaced 10 x 10 feet were planted in 120 plots receiving applications of all combinations of nitrogen, superphosphate, and potash at 0-1-2 levels, or a total of 27 separate treatments. Rates of nitrogen application were 0, 100, and 200 pounds per acre; and the phosphate and potash rates were 0, 50, and 100 pounds per acre. All plots have been clean cultivated periodically to control competing vegetation.

It is too early for conclusions, tentative or otherwise; but some of the fertilizer applications have given good early response (fig. 24).

With more knowledge of nutrient requirements and the probable response to fertilization on representative timber sites, it may become economically feasible to increase the yields of slash pine by fertilization. Growing slash pine in south Georgia to a height of 10 feet or more in 3 years or less would not only increase total yields but would shorten the time needed before the first commercial thinning could be made. If the plantations are grazed, trees of this size ought to be able to withstand much of the serious damage from cattle grazing. However, fast growth or other induced responses may make the trees more susceptible to insect and disease attacks or create troublesome management problems. Already this plantation has a considerable incidence of *Dioryctria amatella* and rust canker (*Cronartium fusiforme*), as well as a heavy infestation of Nantucket pine moth (*Rhyacionia frustrana* (Comst.)).

In evaluating study results of this and similar studies, the economic returns from forage and timber products will be key elements. In the meantime, the Alapaha study and the management problems it poses will interest many landowners in the Southeast who are trying to get a greater financial return from piney woods holdings.

Figure 24.—Vigorous 2-year-old slash pine on clean-cultivated test plot fertilized with superphosphate at the rate of 50 pounds per acre.

First-Year Results from Rates-of-Stocking Study in South Florida

The year marked the start of a major study of rates of stocking cattle on cutover pine forest rangelands in south Florida. After a 2-year calibration period, cattle were turned into pastures on the Caloosa Experimental Range near Fort Myers under three intensities of stocking on January 10, 1958 (fig. 25).

The rates study is a first phase of the Forest Service cooperative range research program in south Florida. It will provide much-needed information on proper stocking to obtain best returns from cattle grazing use of native range. Other important work has been started to find practical ways of raising trees and cattle together on forest rangelands where year-round grazing is practiced. One such study deals with measurement of damage to planted slash pine and longleaf seedlings, sustained under the three intensities of cattle stocking used in the Caloosa rates study.

Figure 25.—Cows graze cutover pine range yearlong in the rates-of-stocking study started in 1958 on the Caloosa Experimental Range in south Florida.

In the Caloosa rates study, animal stocking is adjusted to produce three levels of herbage utilization of pineland threeawn (wiregrass) in the first grazing period after ranges are burned to freshen the forage. Pineland threeawn was chosen as an index to utilization because it comprises over 70 percent (by weight) of vegetative regrowth on burns during the first grazing period. Stocking levels and corresponding degrees of utilization are: *high,* 65 to 75 percent; *medium,* 45 to 55 percent; and *low,* 30 to 40 percent. Accordingly, cattle stocking is adjusted on range units as needed to meet the desired utilization levels.

Since forage grows back rapidly during the winter grazing period after burning, the range is sampled at intervals of about 20 days. With the data obtained, curves of progressive forage utilization are plotted to ascertain trends and to calculate adjustments in stocking rates. For all other grazing periods, the range is sampled at the beginning and end. In addition, ranges grazed for 90 days are also sampled at about the middle of the grazing period to get some measure of regrowth following grazing. By using a system of caged and uncaged plots, total herbage production is determined. From these data, quantity of herbage utilized during a grazing period can be readily calculated.

In 1958, the recovery of herbage following range burning was retarded by cold winter weather. For example, 20 days after cattle were turned onto freshly-burned ranges, the total ungrazed production of pineland threeawn ranged from 29 to 47 pounds per acre, ovendry. At the end of the grazing period in late March, production from plots caged against grazing from the time of burning yielded on an average from 132 to 204 pounds of herbage, per acre, ovendry. Because of this slow recovery, cattle required an abnormally large amount of supplemental winter feed. Because of low herbage production, utilization was higher than desired, even though some cattle were removed to lighten stocking. Average utilization of pineland threeawn was about 58 percent in units stocked at the low rate, 59 percent for the medium, and 71 percent for the high rate of stocking.

Differences in first-year calf production weights, though not entirely due to rate of stocking, were interesting. Calves from herds in range units stocked at low intensity averaged 45 pounds heavier at weaning time than those from herds in units stocked at the high rate. Calf grade on foot at weaning time also seemed to be related to stocking rate, since calves from units stocked at high intensity graded lower than those from pastures stocked at medium and low rates.

FOREST ECONOMICS

Activities in the Division of Forest Economics Research included continuing progress on the Forest Survey, completion of the latest annual surveys of pulpwood production and prices, and work on five special investigations. Some of these projects produced reportable results during the year; others are not far enough along.

Forest Survey work has accelerated considerably during recent years, in spite of the fact that more information is being collected. At the present rate, the cycle of surveys for the five states should be completed in 7 to 8 years (fig. 26). Splendid cooperation from forest industries, the states, and other Federal agencies is largely responsible for the faster progress.

Forest Survey crews completed the third periodic survey of South Carolina and moved into Florida on July 1 (also for the third time). By the year's end they had completed field work in the northwestern portion

Figure 26.—A two-man Forest Survey crew taking measurements on a variable-radius sample plot in Florida.

and reached the half-way point in the northeast (fig. 27). Timber inventory, growth, and cut computations for South Carolina are nearing completion.

This past year we again cooperated with the Southern Forest Experiment Station and the Southern Pulpwood Conservation Association on an annual survey of pulpwood production.

The business recession of 1957 reduced pulpwood production in the Southeast to 10.6 million cords, 4.7 percent below the all-time record level of 1956. However, only pine production actually declined; hardwood increased 8.6 percent to continue its long-term upward trend. Foresters are watching this trend with interest, for it is relieving some of the pressure of pulp industry expansion on the already heavily cut pine and is creating a new market for the more abundant but less-sought-after hardwoods. Also significant from a conservation standpoint is the rapidly growing production of pulp chips from sawmill slabs and other plant residues. It has doubled nearly every year since 1953, and the 1957 output of 426,600 cord-equivalents was 121 percent above 1956.

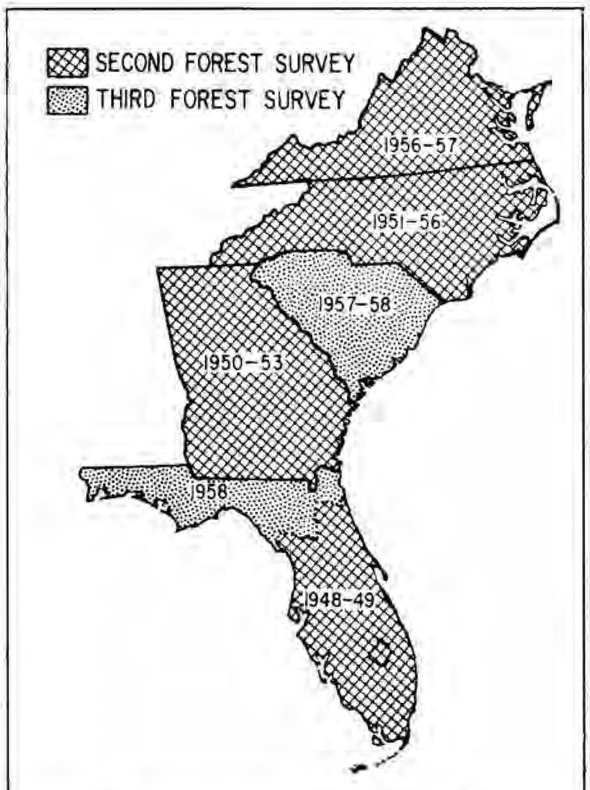


Figure 27.—Status of forest survey work in the Southeastern States.

During the pulpwood price survey, reports were obtained from 18 mills that consume about 70 percent of all the pulpwood and chipped residues produced in the Southeast. This survey revealed only slight changes in 1957 from the price pattern established in 1956. Rough pine pulpwood averaged about 5 cents per cord higher, hardwood about 15 cents lower, and these prices appear to have persisted through 1958. Including dealers' allowances, they are as follows:

PINE (per cord):	
F.o.b. railroad car	$15.20
Trucked to yard	15.40
Trucked to mill	16.35
Average price	15.50
HARDWOOD (per cord):	
F.o.b. railroad car	$12.65
Trucked to yard	12.70
Trucked to mill	13.75
Average price	13.35
PINE CHIPS (per ton):	
F.o.b. point of origin	$ 6.10

The special investigations consisted of four started the previous year and one new one. The former included studies of plantation costs and survival, an analysis of opportunities for new or expanded wood-using industries in an area, an attempt to develop a market valuation procedure for privately-owned tracts of marked sawtimber, and tests of new Forest Survey techniques adapted to use on variable-radius plots. The new investigation deals with the economics of forestry on farm and other small private holdings.

In the plantation cost and survival studies we have enjoyed the cooperation of Duke University, the Soil Conservation Service, the Virginia Division of Forestry, and the Champion Paper and Fibre Company. Efforts to date, in Virginia and South Carolina, have been devoted to exploring the effects of geographic location, soil, topography, existing vegetation, and other site characteristics on the cost of planting pine and on its rate of survival. These efforts are a first step in an attempt to develop a classification of planting sites useful in predicting the cost of and return from establishment and management of plantations.

The industrial development study is in an 8-county area of the North Carolina Piedmont. It is concerned with determining which species, sizes, and qualities of available timber are surplus to the needs of existing industries and whether it is feasible to base new or expanded industries on their ultilization. Most of the necessary field work has been completed, and analysis of the data is under way.

The timber valuation study, in cooperation with the South Carolina State Commission of Forestry, utilizes transaction records for pine sawtimber marked and cruised by Cooperative Forest Management foresters. The objective is to develop a method for appraising the market value of individual tracts.

Research on Forest Survey techniques involved methods of measuring stand density, the use of each tally tree as a sample tree, and development of volume estimating equations. Since July 1957, the Survey has employed variable-radius sample plots in the Southeast. According to this system, each diameter class of trees is tallied on a circular plot of different size, the size of plot being proportional to the size of the tree. The method has a number of advantages over conventional plots of fixed area but introduces complications in obtaining certain descriptive information. A case in point is the measurement of stocking and particularly the assignment of stand condition classes according to the proportions of area occupied by trees of varying merchantability and growth potential. The density study is aimed at developing better methods of obtaining this information.

Work on the problems of small ownerships began in June with surveys designed to explore the characteristics of small owners and their properties, ownership objectives, and the attitudes of owners toward the practice of forestry. Two areas were surveyed — one made up of 8 counties in the North Carolina Piedmont and the other a 9-county area in south Georgia. In each area, 100 small owners were interviewed and their woodlands examined.

A problem analysis to guide further small ownership studies is now being written. Some of these studies lend themselves to a region-wide approach and can be conducted by Asheville personnel; others must be more localized. An economist, recently employed and assigned to Charlottesville, Virginia, will soon undertake a rather intensive study of ownership problems in the Virginia Piedmont.

Trends in South Carolina Forest Area and Timber Volume

Preliminary results of the 1957-58 forest survey of South Carolina show a change of less than one percent in forest area since 1947. Forest area held its own at the expense of agricultural lands, in spite of considerable expansion in the use of lands for reservoirs, highways, suburban development, urban areas, etc. (table 1).

The rate of reduction in South Carolina's agricultural lands apparently is leveling off. Between 1936 and 1947 the area decreased more than 15 percent, but the decline for a similar period between the last two surveys was 6.5 percent.

Pine and pine-hardwood types still predominate in South Carolina, making up 54 percent of the commercial forest area. But both the 1947 and 1958 surveys showed strong shifts toward hardwoods (fig. 28). Pine and pine-hardwood types have decreased more than 1¼ million acres since 1936. Between 1947 and 1958 the decrease amounted to 840,000 acres, or 11.5 percent. Upland hardwoods have almost tripled in area since the original survey of 1936, and lowland hardwoods have increased more than one-third. Area in hardwood types expanded from 27 percent of the total in 1936, to 38 percent in 1947, and 46 percent in 1958.

Sawtimber volume in South Carolina declined almost 12 percent in the past 11 years. Yellow pines and soft hardwoods each decreased about 17 percent, the changes

Table 1.—Comparison of land use in South Carolina, 1947 and 1958

Use class	Area 1947	Area 1958	Change	
	-- Thousand acres --		Thousand acres	Percent
Forest land	11,942.6	12,015.8	+73.2	+0.6
Agricultural land	6,424.3	6,007.3	-417.0	-6.5
Other land	961.1	1,200.3	+239.2	+24.9
All land	19,328.0	19,223.4	-104.6	-0.5
Water	547.2	651.8	+104.6	+19.1
All classes	19,875.2	19,875.2	0	0

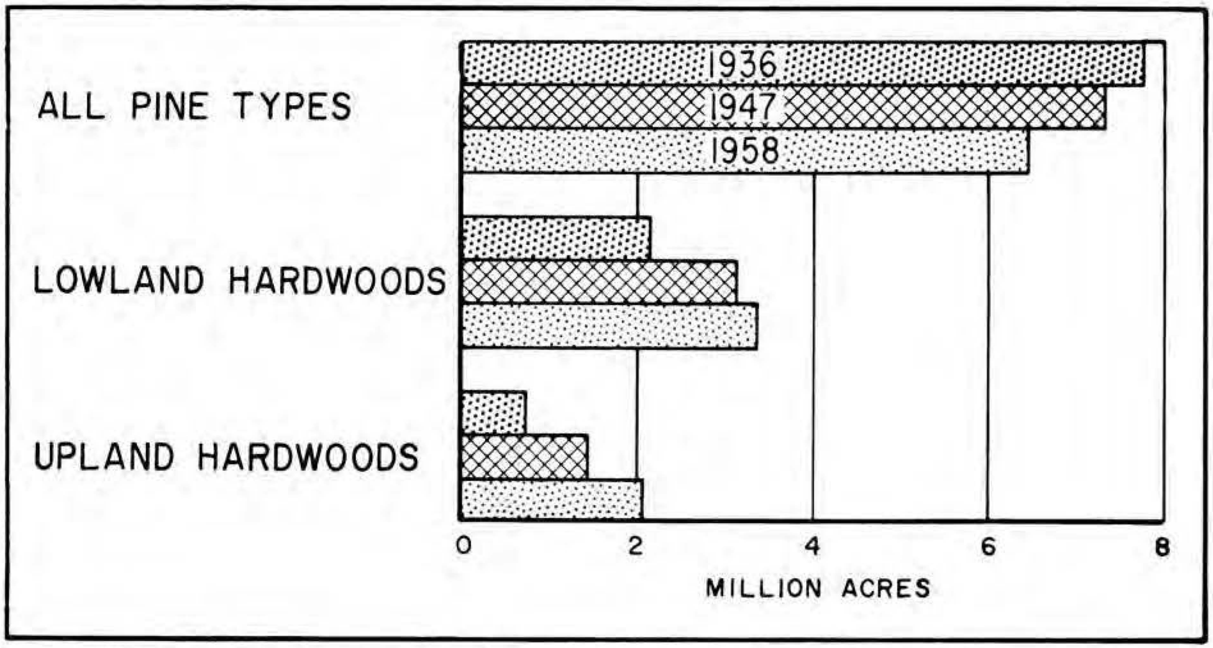


Figure 28.—Pine types in South Carolina have steadily given way to hardwoods.

amounting to 2 2/3 billion and 1½ billion board-feet respectively (table 2). Other softwood sawtimber increased by 13 percent and hard hardwoods advanced 9 percent in volume since 1947.

A reduction of 5 percent also occurred in cubic-foot volume of growing stock. Decreases of 400 million cubic feet in yellow pines and 280 million in soft hardwoods were only partially balanced by a 220-million cubic-foot increase in hard hardwood growing stock (table 3).

Net volume in cull trees has increased with each resurvey. Between 1936 and 1947 cull-tree volumes advanced 6 percent, but the next 11-year period showed a jump of 56 percent. Cull trees, especially large hardwoods, tend to accumulate in stands because timber operators pass them by and leave them uncut.

Figure 29 compares the net cubic-foot volume of all live trees, including those of sound and cull quality, for the three forest surveys. Softwood volume increased through the 16-inch diameter class between 1936 and 1947, but between 1947 and 1958 volumes increased only through the 10-inch class. During both periods rather uniform decreases in softwood volume occurred in the larger tree sizes. In the case of hardwoods, the volume change for each period between surveys was similar, increasing below the 18-inch class, but changing rather little in the larger diameters.

Table 2.—Comparison of sawtimber volume in South Carolina for three surveys

Species group	Year of survey		
	1936	1947	1958
	- - Million board feet - -		
Yellow pines	16,016	15,593	12,932
Other softwoods	1,801	1,511	1,705
Soft hardwoods	8,861	8,695	7,214
Hard hardwoods	3,903	4,343	4,755
All species	30,581	30,142	26,606

New Forest Survey Techniques Developed

Use of the variable plot in gathering Forest Survey data has made it feasible to adopt several other improvements in survey methods. The number of trees tallied on each plot has been reduced to the point where detailed measurements and observations can be taken for each tree tallied without excessive cost, thus making each a "sample tree."

Table 3.—Comparison of cubic-foot volumes in South Carolina for three surveys

Class of material and year of survey	Species group				All species
	Yellow pines	Other softwoods	Soft hardwoods	Hard hardwoods	
	- - - - - - - - - - - - Million cubic feet - - - - - - - - - - - -				
Growing stock:					
1936	4,196	408	2,564	1,168	8,336
1947	4,335	390	2,667	1,436	8,828
1958	3,934	397	2,386	1,658	8,375
Cull trees:					
1936	79	33	425	539	1,076
1947	131	32	531	444	1,138
1958	317	38	765	655	1,775
All live trees:					
1936	4,275	441	2,989	1,707	9,412
1947	4,466	422	3,198	1,880	9,966
1958	4,251	435	3,151	2,313	10,150

Previously, a subsample of tally trees had to be used to obtain detailed information.

The value of sample tree information was increased with the start of the present survey of Florida by abandoning the use of local volume tables based on average tree dimensions over wide areas, and average cull deductions and log grades based on special studies. Now each tree of volume size is measured for merchantable length, diameter, and growth; its cull volume is computed in board-feet and cubic feet; and each saw-timber tree is graded. Also, each tree is classified as to its position in the stand and its present or potential utility. Newly developed volume estimating equations adapted to IBM computation are then used to determine net volume and growth of each tree. These equations are sensitive to one foot of change in height and one-tenth inch change in diameter. The possibilities for analysis of the resulting data are broader and more meaningful, since each sample tree carries its own descriptive classifications and its own volume and growth instead of averages that tend to level out and obliterate information that might otherwise prove to be important.

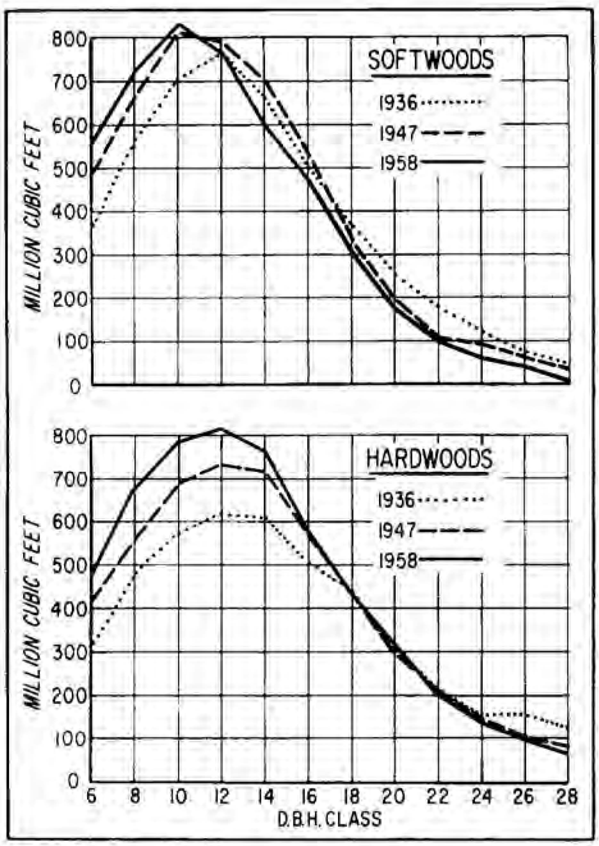


Figure 29.—Total cubic-foot volume has increased most in medium and small hardwoods and decreased most in medium and large softwoods.

A Simple Method of Appraising the Market Value of Pine Sawtimber

The principal use of timber appraisals is in making stumpage sales. Additional needs for appraisals are in determining loan values, settling estates, comparing the results of management systems on research forests, and similar purposes.

Even though the timber market is unorganized, it is relatively easy to find the approximate average price in an area merely by compiling prices received for recent sales. But timber characteristics differ so widely from tract to tract that the "going price" alone would not tell how much a particular lot of stumpage should bring. And on small forests, appraisal methods based on gross returns, manufacturing costs, and profit allowance are too cumbersome to use. However, a simple method of appraising the market value of particular tracts of marked and cruised pine sawtimber relative to the general average price is the result of a current study.

The market value of stumpage is determined largely by the worth of the product it will yield, the cost of converting it to that product, and the competitive condition of the stumpage market. Although stumpage price is also affected by the personalities involved in the transactions, price is the best estimate of "intrinsic" market value. In this study, 20 factors were tested for association with stumpage price. One measured intensity of competition, and another geographic location. Others were believed to influence logging costs, sawing costs, hauling costs, and the value yield of lumber. The data used were taken from 95 sales reported by project foresters to the South Carolina State Commission of Forestry.

Four variables significantly influenced stumpage price. Two of these were stand characteristics — average volume per tree and distance from the tract to the nearest stationary sawmill or concentration yard. The intensity of competition for the timber as measured by the number of bids received also had an influence. Furthermore, price varied geographically from lowest in the upper Piedmont to highest in the lower coastal plain. The independent influence of each factor on the price per thousand board-feet is shown in figure 30. The effect of the average volume per tree on price depended upon the general price level. That is, the premium paid for tracts containing larger-than-average trees is greater when the general price level was high than when it was low. Each additional mile from the mill reduced the price by 13 cents, while each additional bid raised it by $1.25.

Together, these factors accounted for nearly 60 percent of the price variation. The remainder could not be explained for at least two reasons. First, there were no measures

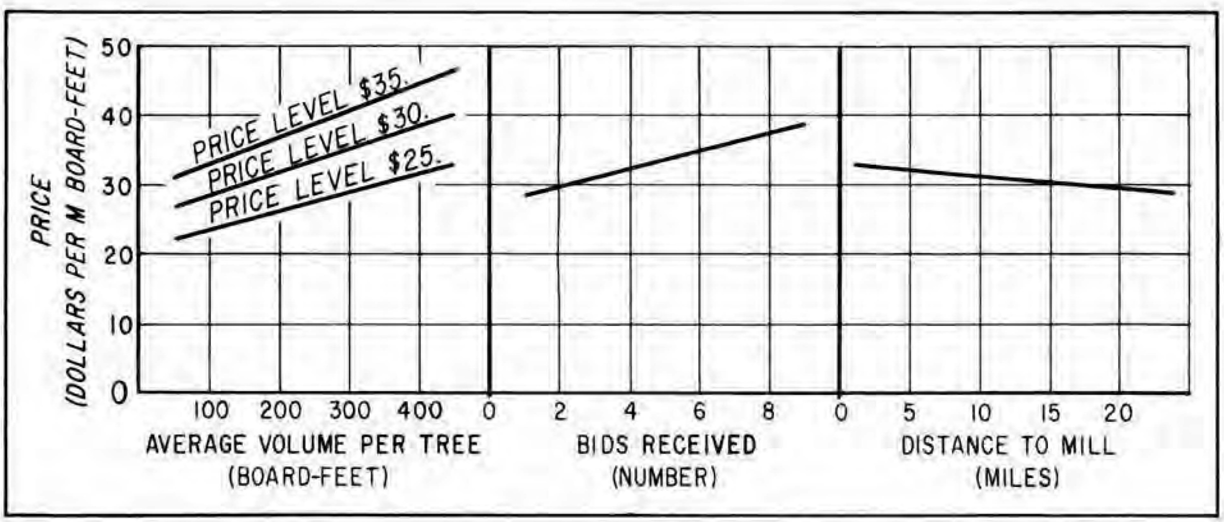


Figure 30.—Independent effect of each factor influencing pine sawtimber price in South Carolina.

of some potentially important factors, such as timber quality and difficulty of the logging chance. But perhaps more important, external factors, such as the relative strength of the positions from which sellers and buyers bargained, caused actual sale prices to deviate from the market values.

This study showed that while periodic price reports can relieve appraisers of the chore of determining the current stumpage price level, an average price in itself is of little value. Some means must also be provided for finding the market value of a particular tract. It was demonstrated in this study that such a procedure is feasible.

The Small Forest Landowner in Two Areas of the Southeast

Nothing in American forestry is of greater concern than the low level of productivity on the Nation's farm and other small private forest holdings. According to *Timber Resources for America's Future,* this problem is especially critical in the South. It further points out that increasing the growth on these lands is the only way to insure adequate future timber supplies. Forest industry and public forests alone lack the capacity to sustain the expected demand for wood.

To find out the characteristics of small forest landowners in the Southeast and what their attitudes were toward growing timber and toward public forestry programs, a random sample of owners was picked in two contrasting areas. These owners were interviewed and their properties examined. One area studied was in the coastal plain of Georgia; the other in the Piedmont of North Carolina. They were approximately equal in size and in area of forest land. The Georgia area was predominantly agricultural, with large, relatively prosperous farms. The few industries were small and oriented primarily toward agriculture and forestry. Forest products markets were well developed. By comparison, the North Carolina area was a rapidly industrializing area. Although the rural population was large, a substantial proportion of these people did not live on farms. The farms in general were small, and off-farm employment was important. The average forest property was also small — only half the size of the average in Georgia. As would be expected, the dollar income from forest products here was less than half that in Georgia.

The characteristics and attitudes of small forest owners in these two areas are summarized in figure 31.

Concepts of timber-growing varied widely among owners who claimed to be growing timber. To some it meant merely making an occasional timber sale. To others it meant refraining from cutting altogether. And conflicting uses, such as heavy grazing, frequently went unrecognized. Owners who were not actively growing timber by practicing forestry often felt that the required investment was beyond their means or that too long an interval would elapse before they received any returns. An additional number of Georgia owners considered their forest uneconomic, either because of its size or the character of the timber. Some North Carolina forests occupied potential industrial or residential sites, so speculative values precluded the practice of forestry.

In both areas free public forestry services, low-cost planting stock, and incentive payments for following specified forestry practices were available. The larger owners were usually the ones active in these programs. and those who joined in one program frequently participated in another. One reason commonly given by owners for not accepting forestry services or planting stock was that they could derive no benefits from the program. In the case of incentive payments, many owners either did not know they were available or were unable to fulfill the requirements. Few owners were unsympathetic with public forestry programs.

The results of this ownership survey indicated some of the major problems and opportunities of inducing this group of owners to practice forestry. For instance, judging by the ages at which owners acquire and relinquish title to land, present owners on the average cannot look forward to owning their forest land more than another 15 to 20 years. This would be unimportant if woodland normally remained in the family from generation to generation. But in about two-thirds of the cases it will be sold as part of a farm property. Because buyers have only a secondary interest in woodland, more money may be realized by selling timber and land separately. Thus, a major task in solving the small forest problem will be motivating owners to improve their forests while reducing incentives to liquidate their timber.

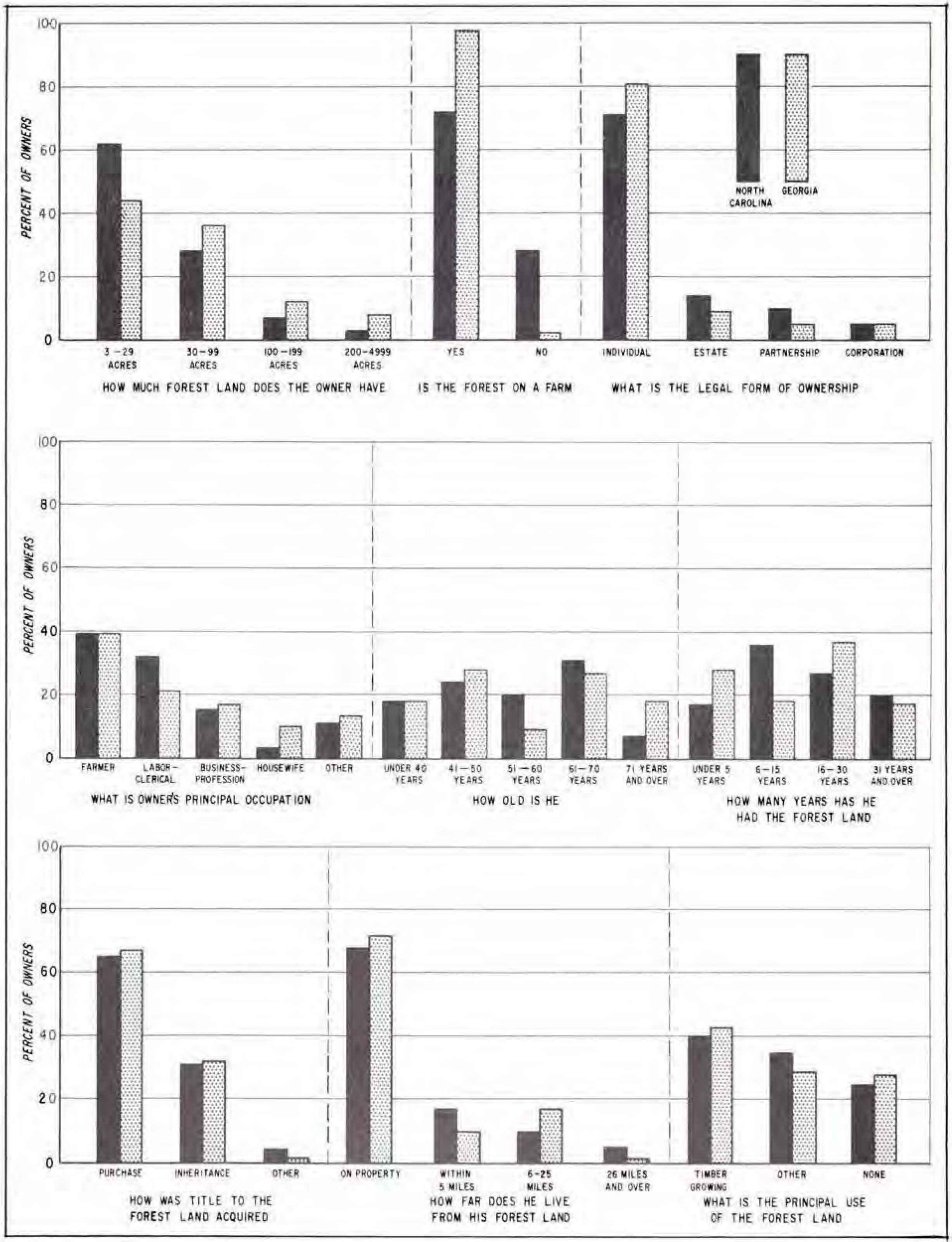
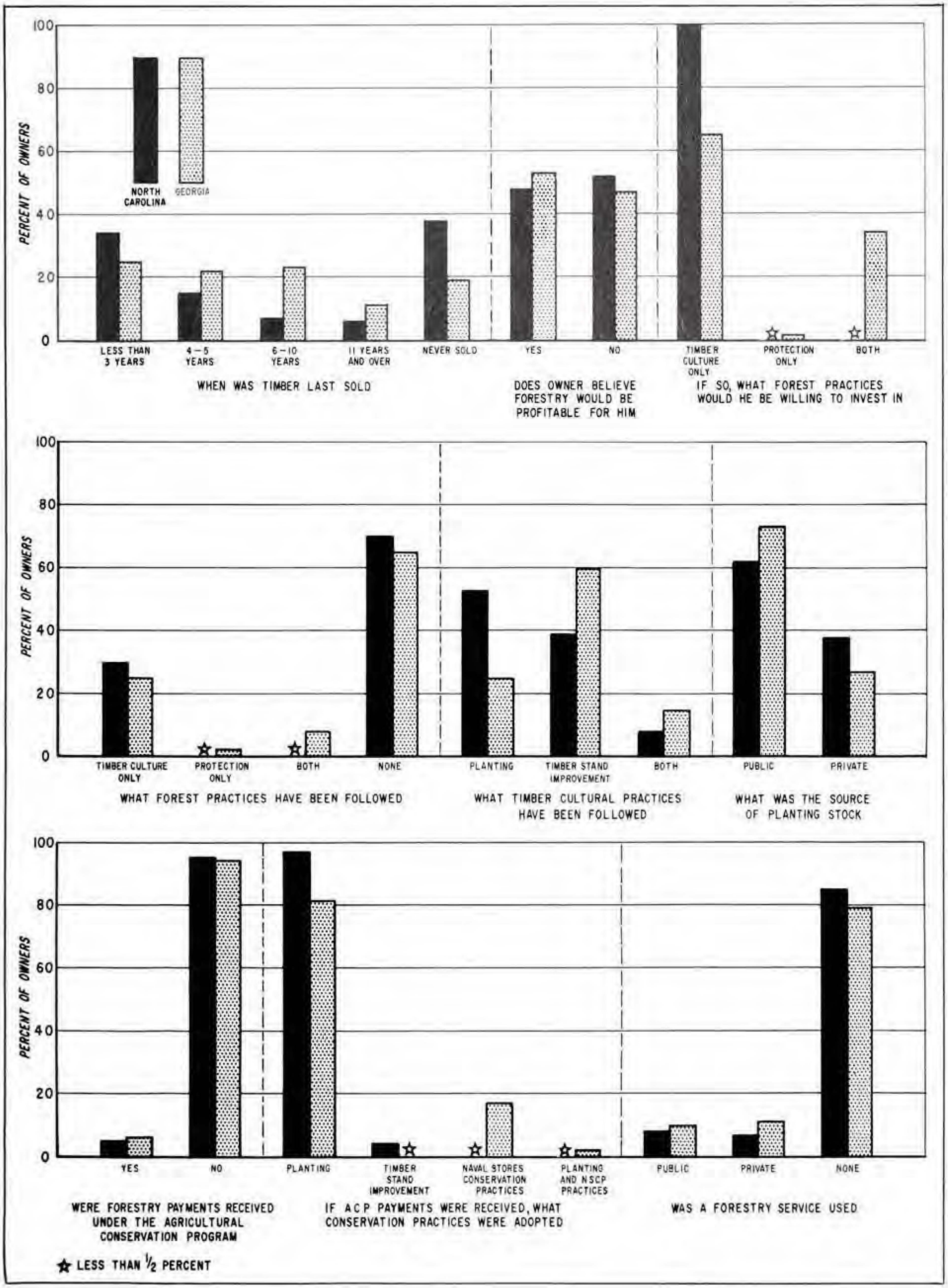


Figure 31.—Characteristics of small forest landowners and their attitudes toward forestry and toward forestry assistance programs.


PERCENT OF OWNERS
NORTH CAROLINA
GEORGIA
LESS THAN 3 YEARS
4 – 5 YEARS
6 – 10 YEARS
11 YEARS AND OVER
NEVER SOLD
WHEN WAS TIMBER LAST SOLD
YES
NO
DOES OWNER BELIEVE FORESTRY WOULD BE PROFITABLE FOR HIM
TIMBER CULTURE ONLY
PROTECTION ONLY
BOTH
IF SO, WHAT FOREST PRACTICES WOULD HE BE WILLING TO INVEST IN
TIMBER CULTURE ONLY
PROTECTION ONLY
BOTH
NONE
WHAT FOREST PRACTICES HAVE BEEN FOLLOWED
PLANTING
TIMBER STAND IMPROVEMENT
BOTH
WHAT TIMBER CULTURAL PRACTICES HAVE BEEN FOLLOWED
PUBLIC
PRIVATE
WHAT WAS THE SOURCE OF PLANTING STOCK
YES
NO
WERE FORESTRY PAYMENTS RECEIVED UNDER THE AGRICULTURAL CONSERVATION PROGRAM
PLANTING
TIMBER STAND IMPROVEMENT
NAVAL STORES CONSERVATION PRACTICES
PLANTING AND NSCP PRACTICES
IF ACP PAYMENTS WERE RECEIVED, WHAT CONSERVATION PRACTICES WERE ADOPTED
PUBLIC
PRIVATE
NONE
WAS A FORESTRY SERVICE USED
LESS THAN ½ PERCENT

FOREST INSECTS

The past year started out extremely cold and the low temperatures wiped out insect enemy number 1, the southern pine beetle, from the mountains. The epidemic, which had for 5 years demanded most of our attention, disappeared.

However, new problems soon appeared to take its place. The elm spanworm, spreading far beyond its previous range, demanded immediate study; a pine sawfly epidemic broke out in Virginia, North Carolina, and Florida; the balsam woolly aphid, notorious killer of fir in the Northeast and Northwest, revealed its potential as it killed a large number of Fraser fir near Mt. Mitchell, North Carolina, and threatened remaining stands. The more familiar insects, such as the bark beetles, the tip moth, pales weevil, and others continued to demand attention.

Figure 32.—A heavy infestation of balsam woolly aphid on the trunk of a Fraser fir.

Several personnel changes took place during the past year. Survey leader William McCambridge transferred to Albuquerque, and an assistant, William Carter, was called into the army for 3 years. Eben Osgood left his silvicultural control studies for advanced study at Minnesota. However, good replacements are gradually being added. Gene Amman of Fort Collins, Colorado, came into the research unit in August, and Robert Davis, now in medical entomology, will join him early in January. Harry Yates came to Macon from Duke to work in the nursery project; the tip moth is his major problem at present. Edward Merkel and Bernard Ebel are making good progress in their research on cone insects at Lake City, Florida.

Balsam Woolly Aphid

The balsam woolly aphid, *Chermes piceae*, related to destructive species in Europe, was discovered in the fall of 1957 on Fraser fir on the highest mountain in the Southern Appalachians. Aerial and ground surveys of the 7,000 acres of fir around Mt. Mitchell revealed that the aphid is distributed throughout the area; a large number of firs have already been killed, and more may be expected to die in the next year or two.

An infestation also exists near Skyland, Virginia, on the Blue Ridge Parkway, where the bracted balsam fir grows in mixture with Fraser fir; tree killing is not severe, but "gout" symptoms caused by aphid attack are common. To date the insect has not been detected in other Fraser fir areas in the Southern Appalachians.

Aphids attack the trunk and twigs of a tree and appear as specks of wax on the bark (fig. 32). When several million of these tiny insects feed on a tree through their needle-like mouthparts, they cause adverse changes in cells which affect translocation and lead to mortality.

In addition to the surveys already mentioned, aerial and ground checks of all fir stands are being continued. Tests of insecticidal control have been conducted to determine whether this method is feasible in areas which can be reached with ground spraying equipment. A pilot test is being planned to determine whether the aphid can be controlled by the application of insecticides in scenic areas. Methods of preventing spread of the aphid from infested to noninfested areas through quarantines are being explored. Cutting studies are being conducted to determine whether the spread of the aphid within and between infested areas can be controlled. Consideration is being given to the possibility of finding firs that are resistant to aphid attack. Basic to all these investigations, the life history and behavior of the insect in this area is being studied.

Elm Spanworm

The area infested by the elm spanworm in 1958 showed an increase of 270,000 acres over last year. The forests of northern Georgia, where the epidemic began in 1954, suffered less severe defoliation than in the previous year. The spread of the infestation since its initial detection is tabulated as follows:

	Area of defoliation	Damage
1954	Localized in small, scattered groups of trees	None apparent
1955	1,500 acres along the tops of the ridges	None apparent
1956	50,000 acres, principally along the tops of the ridges of northern Georgia	Some growth loss
1957	300,000 acres in Tennessee, North Carolina, and Georgia	Growth loss and dying of occasional trees
1958	570,000 acres in Tennessee, North Carolina, and Georgia	Growth loss and death of hundreds of trees defoliated for 2 or more years

Studies begun in 1957 to determine growth loss were continued this year. It was found that the trees most severely defoliated were growing only half their normal rate, while tulip poplar, which escapes defoliation, showed average or increased growth during the same period.

A study of the effect of last winter's low temperatures on the viability of elm spanworm eggs showed that the low temperatures had no effect on the viability of the eggs.

A pilot test was conducted in May to determine whether the insect could be controlled by airplane spraying of DDT. Six 50-acre plots (two plots at elevations of 1,700, 2,400, and 3,200 feet) were sprayed with one pound of DDT in 1 gallon of kerosene per acre to determine whether variation in foliage and insect development would influence the degree of control. Studies of the insecticidal effects (fig. 33) showed that the treatment was over 99 percent effective at the two higher elevations where the spray was applied during the earlier stages of insect and foliar development. Successful but somewhat less effective control was obtained in the lowest plots; the greater mass of foliage screened out the insecticide before it reached larvae feeding on the lower, protected leaves of the trees.

Pine Sawflies

In May an epidemic of pine sawflies, identified as the Virginia pine sawfly, *Neodiprion pratti pratti*, was detected on the Piedmont Plateau of North Carolina and Virginia (fig. 34). The epidemic ranged over some 400,000 acres, with about 130,000 acres of Virginia and shortleaf pines actually defoliated. Only one generation of these sawflies occurred, and feeding was completed prior to the emergence of the new foliage. No evidence of tree mortality has been observed. Committees to deal with the epidemic were formed soon after initial surveys were made. As a result, sampling plans have been developed for conducting egg surveys early in 1959 in both States. A control program will be drawn up if surveys show that another epidemic may develop.

During May in Taylor County, Florida, local feeding on loblolly pine by a sawfly identified as *Neodiprion exitans* was observed. By October two additional generations had occurred and defoliation had encompassed approximately 300,000 acres of loblolly pine forests in west-central Florida.

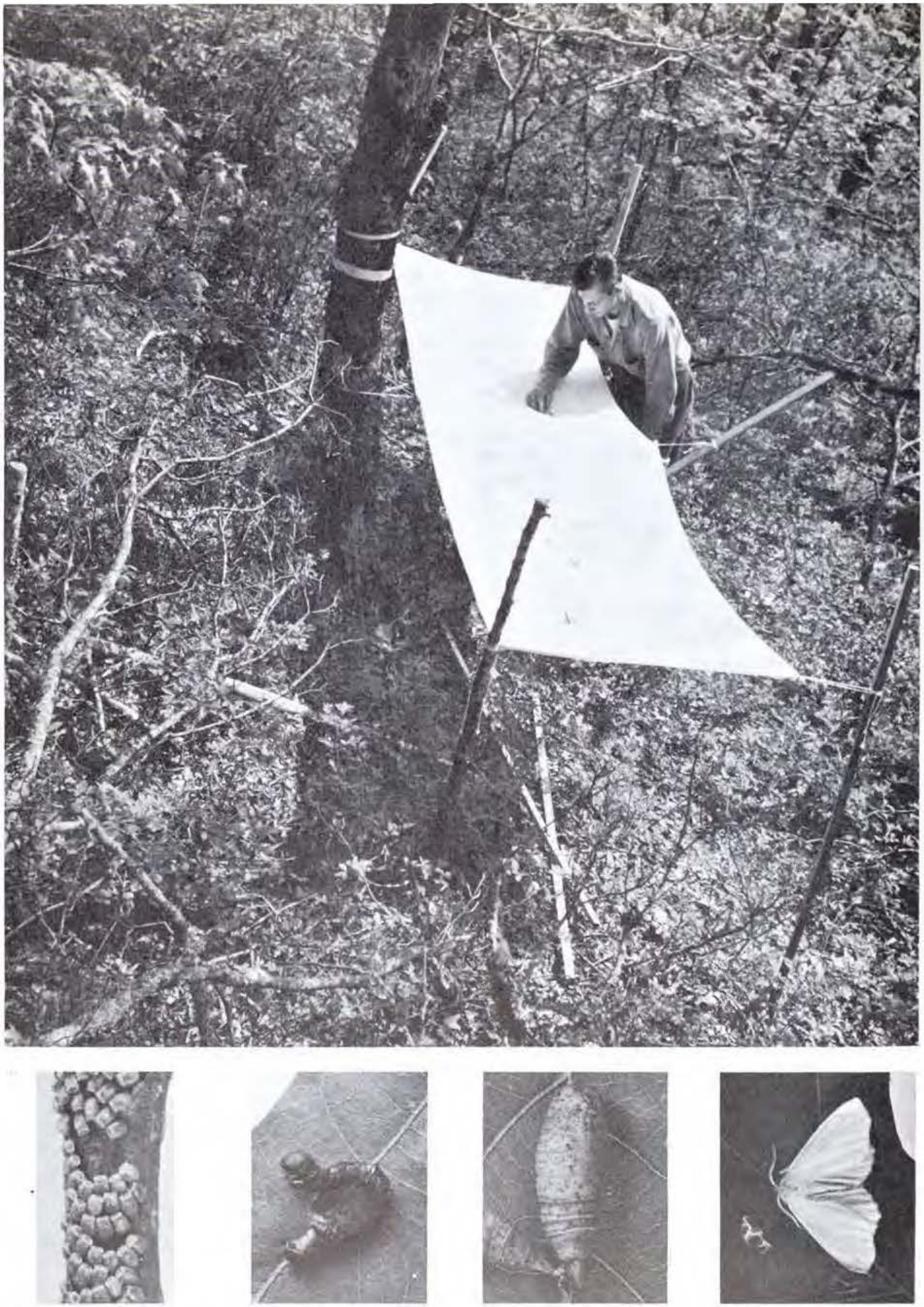


Figure 33.—Cloth tray beneath crown to catch sample larval mortality population. Inserts show, left to right, eggs, larva, pupa, and adult of the elm spanworm.

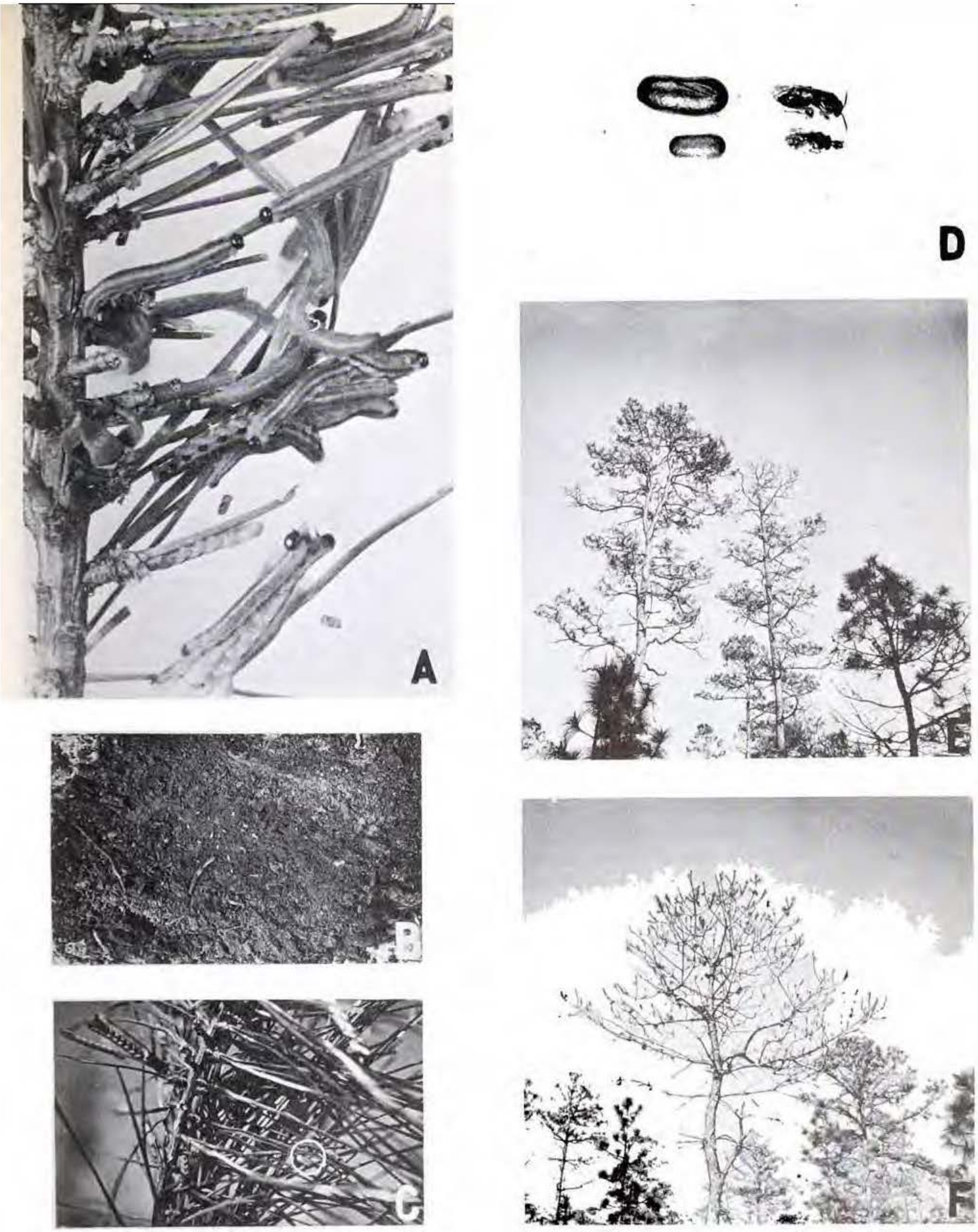


Figure 34.—Sawflies defoliated thousands of acres of pine in Virginia, North Carolina, and Florida. A, Mature larvae feeding on pine needles. B, Cocoons are spun in the soil. C, A cocoon attached to needles. D, Cocoons and adult sawflies; the female sawfly is larger. E, Sawfly defoliation of pine. F, Some trees are completely stripped of needles prior to emergence of new growth in the spring.

At present it appears that a high predator population is developing, and investigations will be continued until it is determined whether or not control is necessary.

Nantucket Pine Tip Moth

During the past year considerable time has been devoted to the biology of the Nantucket pine tip moth in Georgia. Migration of the larvae has been found to be as much as 14 inches from the point where eggs were laid to the point where the larvae bore into the shoot. The first larval instar spends at least several days feeding on the outside of the tips and needles; whether later instars do so must be determined. This indicates that foliar sprays aimed at the larvae can be applied after eggs have hatched.

A number of systemic insecticides have been tested as foliar sprays in exploratory studies. Both guthion and systox proved considerably better than some chlorinated hydrocarbons. Although systemics presently have certain limitations, they appear to offer considerable promise in the development of a successful method of tip moth control.

Aerial spraying of a seed orchard for tip moth control was conducted. Under the conditions of the test, DDT applied in dosages as high as 5.3 pounds per acre failed to give as good control as that obtained from the application of a 2 percent DDT emulsion with a hydraulic sprayer in an adjacent area.

Seed Insects

Several species of Dipterous insects have been found breeding in seed testing germination trays at the Forest Service seed testing laboratory at Macon, Georgia (fig. 35). One species of fungus gnat, *Bradysia coprophila* (Lintn.), was found in great numbers feeding on the ungerminated red pine seeds of a test from Michigan. At least two other species of yet unidentified Diptera have been collected from germination tests. Although only certain seed lots seem to be affected, the possibility of local infestation exists. All affected seed lots have exhibited below average germination percentage, thus indicating that these insects might play a rather important role in the success of seed germination in the field.

Pales Weevil

During the past 4 years a series of dips, sprays, and dip plus granular treatments have been developed by this Station to protect seedlings from being killed by weevils on recently cutover pine lands. This year a study was made using ½-, 1-, and 2-percent concentrations of aldrin to determine whether lower concentrations of insecticide could be used for treatment. From an economic standpoint the added protection provided by the two higher concentrations of spray and granular material is offset by the increased cost of insecticide. However, in the case of the dip treatment, because very little material is used, the small additional cost of the 2-percent material over the lower concentrations is more than offset by the larger number of seedlings which survive.

Insects Destructive to Flowers, Cones, and Seeds of Pine

A study to determine the identity of insects which damage flowers, cones, and seeds of slash and longleaf pines began in 1958. Collections to date indicate that three species of *Dioryctria* cone moths are common and cause extensive damage. Other insects warranting further study are thrips on female flowers, two species of lepidopterous larvae plus xyelid sawfly larvae on male flowers, scale insects on first-year cone stalks, cecidomylid fly larvae in cones, and *Laspeyresia* spp. seedworms in cones.

Records of Dioryctria-caused damage to mature slash pine cones have been kept since 1956 for 10 trees in a seed production study on the Olustee Experimental Forest (table 4). An interesting feature of this data is the surprising uniformity in total cone yield for the three consecutive years. It should be noted that the table does not reveal damage by *Dioryctria* spp. to cones during their first year of development. Further research is needed to determine the total impact of insects from flowering through cone maturation.

Tests were started to determine the susceptibility of a destructive pine coneworm, *Dioryctria abietella* (D. & S.), to residual deposits of different insecticidal water emulsions. Larvae for the tests were obtained from continuous mass cultures of this species by special rearing techniques (fig. 36) developed over the past 2 years.

Figure 35.—Dipterous larvae and seeds of pine damaged by them.

Results of a preliminary study indicated that, on a given slash pine, second-year cones were more likely to be attacked by *Dioryctria* spp. larvae when they occurred on branchlets bearing first-year conelets infected by the southern cone rust disease. Conversely, the second-year cones showed a significantly lower incidence of coneworm attack when associated with healthy conelets.

Southern Pine Beetle

During the 1957-58 winter in the Southern Appalachians there were several periods in which subzero temperatures were recorded. Studies to determine extent of mortality to the overwintering broods of the southern pine beetles were made throughout the epidemic area. These studies revealed that in

Table 4.—Dioryctria damage in mature slash pine cones from 10 representative trees in a seed production area, Olustee Experimental Forest, Florida

Cone-damage classification	1956 cone crop		1957 cone crop		1958 cone crop	
	Number	Percent	Number	Percent	Number	Percent
Sound	1,500	56	2,443	88	2,167	77
Partially damaged	654	24	234	8	277	10
Completely destroyed	542	20	103	4	353	13
Total	2,696	100	2,780	100	2,797	100

Figure 36.—Petri dish rearing container used in the mass culture of Dioryctria abietella larvae for insecticide screening tests. Note waxed slash pine conelets used for larval food, and frass pushed out of conelets by boring larvae.

all infested areas between 95 and 100 percent of the hibernating stages, except the egg stage, had been killed. (The egg stage makes up a small part of the overwintering population.) The effects of these temperatures on the predatory clerid beetle were also observed, and it was found that its populations were reduced only 40 percent. The feeding activities of these beetles, plus other natural control factors, were expected to reduce southern pine beetle populations to a negligible level.

On the basis of the above findings, the chemical control program which has been in progress for several years was halted. Aerial surveys of infestation areas and ground checks continued until fall. No active outbreaks were detected or reported from the epidemic area.

Southern pine beetle activity on private lands in eastern North Carolina was reported during early June. Aerial surveys in June, September, and December revealed the presence of 450, 800, and 200 fading trees respectively. These data, together with information gained from ground examinations, showed that the outbreak had definitely subsided by December. It appears that the epidemic will be at a very low level in 1959.

Black Turpentine Beetle

Attacks in the spring by the black turpentine beetle in stumps and uninjured pines in logging areas in the Southern Appalachians were reported to have been more frequent than in previous years. Although infestations had been fairly heavy in western North Carolina, this condition existed for only a short period and no chemical control was required. Throughout 1958, virtually no attacks by the beetle occurred on the coastal plain from Virginia to Florida.

FOREST DISEASES

This Division has been going through an orderly process of evolution and wears quite a different face than it did 5 years ago. At that time we were still working out the cause of littleleaf, we were just coming to grips with oak wilt, and nursery diseases were taking a heavy toll, unchecked, in several states. No one seemed to care about cone rust, and white pine blight and annosus root rot raised few foresters' blood pressure.

Today the littleleaf picture is far clearer to us, and we are well along on a program of breeding for resistance (fig. 37). Oak wilt is firmly entrenched as far south as southern North Carolina and Tennessee, but control measures developed by timely research show promise of keeping losses low. Two new men are off to a good start in cone rust control, stimulated by the huge toll the rust takes of the slash pine cone crop in Florida. One man devotes his main effort to the complex known as white pine blight — a spectacular littleleaf-like decline that is killing pines over a wide area in east Tennessee. Excellent control of nursery root rots has been achieved and put in practice, and two men are assigned to soil fumigation work and other nursery diseases, such as fusiform rust, chlorosis, cedar blight, et al. *Fomes annosus*, a fungus native to the U. S. and also the leading forest pathogen of Europe, is now showing its colors in our South, and heavy losses in many white and slash pine plantations have forced us into a major study of its behavior and control.

Our work is organized along three main lines — nursery diseases, forest diseases, and disease surveys. Pathologists are located at Asheville, Raleigh, Athens, Macon, and Lake City. Our staff, although not large, is strong and well balanced, with six Ph.D.s, two almost Ph.D.s, two Masters, and three other experienced men. Recent additions that we are confident will strengthen our work

Figure 37.—Shortleaf pine seed orchard at Athens, Georgia, composed of grafted selections from trees showing resistance to littleleaf and having other desirable characteristics. Grafts made in 1953. Each row is from scions from one selection. Note large difference in growth of different clones.

greatly are: Otis Maloy and Fred Matthews at Lake City, Charles Berry at Asheville, Charles Hodges at Raleigh, and Samuel Rowan at Macon.

Nursery Diseases

Black root rot of southern pines is now known to occur in at least eight coastal plain nurseries. Hodges had shown that it can be caused by species of Fusarium and Sclerotium that produce indolacetic acid during hot weather (fig. 38). Nematodes appear to have a secondary role in the disease. Fumigation tests continue to show superiority for methyl bromide over other materials tested. One field has produced four successive seedling crops free of root rot after one fumigation with methyl bromide.

Spraying for fusiform rust control only when weather conditions are conducive to spore dissemination and infection confirmed our earlier findings that "prescription" spraying can cut the number of applications by as much as two-thirds. Properly timed sprays, either by prescription or by fixed schedule, gave excellent rust control in 1958.

Damping-off is accentuated by cool weather during the first 2 weeks after planting, and by early application of nitrogen fertilizers to the seed beds.

Of 40 fungicides tried for control of Arizona cypress blight in Georgia, phenyl mercury dithiocarbamate was the most promising. All of the mercury compounds helped some, but none eliminated the disease. Phomopsis blight of redcedar in North Carolina was partially controlled with Semesan and with Kromad.

Cylindrocladium scoparium causes root rot and top disease in white pine and Fraser fir. Methyl bromide, applied before sowing, will check it effectively for one growing season. However, the disease can become very severe the second season after fumigation.

Figure 38.—Constant-temperature tanks at Macon, for the study of black root rot and chlorosis.

Cone Rust

A major destroyer of slash and longleaf pine cones is the rust caused by *Cronartium strobilinum* (fig. 39). New research aimed at direct control is under way. Slash pines were sprayed with ferbam, captan, Basi-cop, and Puratized Agricultural Spray (PAS) in an attempt to control damage by the rust. Only ferbam appeared to reduce rust incidence.

In another study, the four fungicides were tested individually on female flowers on 18 slash pines for control effectiveness and toxicity. Ferbam, captan, and Basi-cop did not harm the tender flowers, while PAS proved to be injurious. A low incidence of rust on the experimental area was noted after a wildfire along the windward side destroyed a heavy concentration of runner oak just prior to the time when flowers were receptive. This oak is one of the primary alternate hosts of the rust. This accidental "control" will be exploited in next year's studies to determine the effectiveness of control burning in preventing rust damage.

A third study tested the effect of the four fungicides on the germination of slash and longleaf pollen. Captan and Basi-cop markedly inhibited germination, and PAS proved to be lethal. Ferbam, however, stimulated germination beyond that of the untreated series.

Blister Rust Control

Mortality of white pine from blister rust continues a steady increase in a 2.5-acre unprotected (no ribes removed) study plot in Ashe County, North Carolina, indicating losses to be expected at the higher elevations (table 5).

Table 5.—White pine losses from blister rust in an unprotected area in North Carolina

Tree size, 1946	Trees observed	White pine mortality			
		1946	1950	1954	1958
	Number	- - -Percent - - -			
Over 10 feet high	117	1	4	8	11
1-10 feet high	34	0	15	38	38
Seedlings up to 1 foot high	100	0	2	12	25

Figure 39.—Cone rust on slash pine. Left, swollen, rusted, first-year cone. Right, normal, healthy, first-year cone.

Five new centers of infection on white pines were found in Ashe and Watauga Counties, North Carolina, and one in Johnson County, Tennessee. Severe losses had occurred at two small stands of young white pine in North Carolina where no ribes had been removed. Negligible damage was done at the Johnson County center, where ribes were removed. Aecial production during the spring was the heaviest on record in North Carolina.

Technical assistance was given the states of North Carolina and Tennessee in conducting pre- and post-planting examination of privately owned white pine plantations, ribes suppression work, and related activities. In North Carolina, plantings totaling approximately 76,000 trees were found exposed to blister rust infection from ribes growing nearby.

White Pine Blight

White pine blight is a disease or a complex of diseases that results in either dieback, shortening, or chlorosis of needles, or a combination of these symptoms (fig. 40). Many affected trees die. The cause is not definitely known, although the disease has been noted in the east for many years. The Station began a cooperative study with TVA, the Tennessee Division of Forestry, and the University of Tennessee in 1957. Although major attention is given the disease as it occurs in eastern Tennessee, it is also being followed in Virginia and West Virginia.

There was little change in the condition of blighted trees in West Virginia and Tennessee in 1958 compared with 1957. Because of the somewhat different symptoms, it is not yet clear whether the disease is the same in both areas.

Blighted pines have poorer root development and fewer living root tips (table 6), but as yet no pathogenic fungi have been isolated from the roots. Imbibitional water values of soils in blighted stands were lower than those of "healthy" soils, indicating that "blight" soils may not retain water as well.

Grafts of healthy shoots on diseased, diseased on healthy, and diseased on diseased twigs are under study. Also, blighted seedlings are being transplanted within and to areas outside of blight occurrence. The responses observed on these tests are expected to provide clues as to whether we are dealing with a pathogenic or a physiologic disease.

Figure 40.—White pine blight in Tennessee. Left, two blighted trees; center, blight-killed tree; right, healthy tree.

Table 6.—Living root tips on blighted and healthy pines

Locality	Stand condition	Month examined	Root tips living	
			Blighted trees	Healthy trees
			- - - - Percent - - - -	
Pocahontas County, West Virginia	Diseased	June	31	61
Pocahontas County, West Virginia	Diseased	June	33	51
Morgan County, Tennessee	Diseased	Sept.	20	39
Greene County, Tennessee	Healthy	Sept.	--	30

Fomes Annosus Root Rot

Fomes annosus has not been damaging in the Southeast until recently, except as a killer of redcedar. Now, however, cases of windthrow and outright killing of white pine in North Carolina and Virginia and slash pine in Georgia and South Carolina by *F. annosus* are causing concern (fig. 41).

Most of the stands with much root rot had previously been thinned. Thinning provides stumps in which the fungus builds up. Thinned plantations appear to be vulnerable because of the proximity of roots of individual trees, and because planting results in dead, strangled roots that serve as entrance points for fungus. Several instances of root rot have also occurred in thinned natural stands of white pine, however, so this is not strictly a plantation disease.

Site factors may be important, too, in favoring root rot. For example, the soils in three infected white pine stands were found to be more droughty than soils in nearby areas free of root rot.

The English stump-creosoting control method is under test in several newly thinned stands to see whether it reduces the incidence of root rot by preventing *F. annosus* from colonizing fresh stumps.

Mycorrhizae of Southern Pines

An investigation of the mycorrhizae of shortleaf, loblolly, slash, and longleaf pine is being made so that we can better understand the role they play in the nutrition of these species and determine their effect upon the resistance of the roots to attack by parasitic organisms.

A first step is the identity of the mycorrhiza-forming fungi. This is being done by growing seedlings aseptically (fig. 42), and inoculating the root medium with different suspected mycorrhizal fungi. Seedlings of the four species are being grown in association with over a dozen basidiomycetes, including such common mushroom-formers as *Clitocybe laccata, Amanita muscaria, Lepiota procera,* and *Boletus betula.*

Clitocybe laccata appears capable of synthesizing mycorrhizae when associated with roots of shortleaf, loblolly, slash, and longleaf pine; *Amanita muscaria* with roots of slash and loblolly pine; and *Lepiota procera* possibly with roots of shortleaf, loblolly, and slash pine.

Figure 41.—Fomes annosus root rot in a 31-year-old white pine plantation in North Carolina, thinned in 1948. The trees blown over are badly root rotted.

Figure 42.—A loblolly pine seedling grown aseptically from seed and later inoculated with a mycorrhizal fungus.

Oak Wilt

Data are now becoming available on the efficiency of the wilt control method in use in North Carolina and Tennessee. This method consists of felling only the wilting trees, poisoning the stumps with Ammate, and spraying the hole and limbs with a BHC-DDT-Penta mixture in fuel oil. Control efforts began in the North Carolina counties in 1954 and in Greene County, Tennessee, in 1955; no control has been in effect in Washington County, Tennessee. Table 7 shows the encouraging control results, judged by active new centers per 100 square miles of area in 1958, as compared with the situation before control was started.

To follow the wilt-spread pattern, 100 treated centers are scouted on the ground annually to a radius of 300 feet. In 1957 there was new wilt at 27 centers, and only 1 case occurred beyond 50 feet from a wilt tree. In 1958 there was new wilt at 32 centers and none was beyond 50 feet. This pattern suggests that we are controlling long-distance spread but not local spread. In the case of 9 active wilt trees near other wilt trees that yielded the fungus from the stump and roots, no infection via root graft was found after extensive root excavation. In the case of 12 others, the fungus could not be isolated at stump height. Thus, in most of these cases of local spread, root-graft transmission can be questioned.

An east-wide system of post-control appraisal, in which this Station has a part, has been started. Southern Appalachian plots are being established in treated areas in North Carolina and treated and untreated plots in Tennessee.

Defect in Piedmont Hardwoods

An extensive 3-state study of hardwood defects with regard to their abundance and seriousness has clearly shown that most trees approaching or just above minimum saw log size have so many minor defects, that, using the next poorest face of the butt log as the index, less than two percent of the combined butt log lengths would have yielded 2-foot clear cuttings.

Table 7.—New wilt centers in 1954 and 1958 in relation to treatment applied

County	Surrounding situation	Treated	New wilt centers per 100 sq. mi.	
			1954	1958
Buncombe and Haywood Counties, North Carolina	Little wilt around them	Yes	1.2	1.4
Greene County, Tennessee	Surrounded by "wilt counties"	Yes	1.2	4.5
Washington County, Tennessee	Surrounded by "wilt counties"	No	1.1	14.5

Considering each defect individually, knots and branching led the causes of degrade. Other small defects resulted from several insects, from birdpeck, and from scarring, and caused heavy quality losses because they were so numerous. Stem diseases, including rots, lead more to outright cull than defect; the same is true of sweep and crook.

A manuscript has been prepared on the study and gives much new information on defects, their extent, and stand factors related to defectiveness.

Search for Blight Resistance in Chestnut

Now that the blight has had ample time to "saturate" the chestnut population, any freedom from disease on the part of trees of pole size or larger might be expected to indicate true resistance. An intensive search is under way for such trees. About half of the many resistant cases reported have proved to be Asiatic species. Most of the rest proved unfit for testing because of blight or small size. A few trees with some promise have been found, and scions from them will be grafted to American and Chinese chestnut stocks this coming spring by TVA. The work is part of a joint project with this agency and the Northeastern Forest Experiment Station to try to discover and propagate resistant chestnuts.

Miscellaneous

Pitch streak is a disease of unknown cause in turpentined slash pine in south Georgia and Florida. In 1958 there was a reduction in both the intensity of the disease and in mortality of affected trees. Although additional cases have been found, the incidence of pitch streak appears to be leveling off. The disease is now thought to be strongly influenced by drought conditions. Thus, increased rainfall in pitch streak areas during the past several years is believed contributory to the reduced activity of the disease.

Oaks continue to die from unexplained causes in some areas, and systematic observations are now being made on plots in north Georgia to supplement the work of the Northeastern Station on this problem.

Diseases that were prominent in causing damage in 1958, other than those already discussed, included spot anthracnose and Ascochyta leaf spots of dogwood, Elsinoe leaf spot of oak, hemlock twig rust, and mimosa wilt. Reports of mimosa wilt have been received from widely scattered cities as far south as Gainesville, Florida.

FOREST MANAGEMENT

The forest management research program was strengthened in 1958 by the addition of new personnel, funds for the construction of new laboratories, and expansion and reorientation of portions of the program.

The expansion of seed production research made it possible to employ Dr. Robert L. Barnes, a plant physiologist exceptionally well qualified by education and experience. With the cooperation of Duke University, he is now stationed at the Botany Department, where excellent laboratories and outstanding technical counsel are available. Under the general supervision of our Lake City Research Center, Dr. Barnes will plan and conduct studies of the physiological and biochemical processes involved in the flowering and seed production of forest trees. These studies will include determination of the kinds and proportions of organic compounds in flower and vegetative buds throughout the period of bud differentiation and development, the factors affecting the proportions and concentrations of these compounds, and the critical levels of these compounds for bud differentiation. His first efforts are being directed at the physiology of flowering in slash pine.

Another plant physiologist, Dr. Mason Carter, has joined the Athens-Macon Research Center staff to help organize a seed research laboratory in conjunction with the regional Seed Testing Laboratory at Macon, Georgia. The purpose of the seed research laboratory is to make certain that the latest advances in plant physiology, biochemistry, and related sciences are brought to bear upon seed problems to insure the highest quality seed for the lowest cost. Dr. Carter will provide the specialized technical knowledge and skills necessary to develop and carry on an effective seed research program.

All phases of the research program at Lake City, Florida, will soon be housed in a new building on the Olustee Experimental Forest (fig. 43). The new building is designed as a research laboratory and administrative unit and will contain 8,700 square feet of air-

Figure 43.—Architect's drawing of office-laboratory planned for the Lake City, Florida, Research Center. The building is scheduled for completion in 1959 on the Olustee Experimental Forest.

conditioned space. The center of the building will have a utility core that will supply fume, dust, heat, and humidity control to the genetics, physiology, soils, pathology, and entomology laboratories grouped around it. The offices lining the outer walls will house a well-balanced research team under the supervision of Dr. Karl F. Wenger. The forest management research project is under the technical direction of Pieter E. Hoekstra, and the genetics and physiology research project is headed by Anthony E. Squillace. Mr. Squillace came to Lake City from the Intermountain Forest and Range Experiment Station, where he had spent a number of years selecting and breeding blister-rust-resistant and otherwise improved strains of western white pine.

The forest management research program in the Carolina Piedmont has been reoriented by shifting the supervision of the Hardwood Research Project at Statesville, North Carolina, from the Union Research Center to the Asheville Research Center. This move allows David F. Olson, Jr., to serve as project leader for forest management research in both mountain and Piedmont hardwoods. The move also permits Dr. Louis J. Metz, Research Center Leader at Union, to give regional direction to the Station's forest soils research program and to begin the development of a soils laboratory (fig. 44) that will serve the soils-site studies being conducted at all the station's research centers.

The establishment of a research unit at Charlottesville, Virginia, has enabled the Franklin Research Center to extend its program into the Piedmont and mountains of Virginia as well as the coastal plain of Virginia and North Carolina. The new unit, under technical leadership of Glenn P. Haney, will be concerned with both the silvicultural and economic problems of forest management. This dual character of the Charlottesville unit simply recognizes the fact that while silviculture and economics can be neatly pigeonholed on paper, they are inseparable on the ground. The small ownership problem deserves and will receive special consideration in the Charlottesville plans, since 90 percent of the forest land in the Virginia Piedmont is in small holdings. Although the intermingled industrial landowners have made great progress toward intensive management of their lands, the condition of these small holdings is about as poor as any in the United States. Since silviculture is not strongly affected by size of holding, it is obvious that the differences are in the economics of forest management. The Charlottesville unit will attempt to develop schedules of costs and returns for various types and intensities of forest management practices and then use this information to determine the place of forestry in the farm enterprise. The major lines of silvicultural research will be species-soils-site relationships and the management of shortleaf and Virginia pine.

Figure 44.—The Union soils laboratory is being modernized with new and more efficient soil testing equipment.

In the coastal plain, the Charleston Research Center is starting a new program aimed at the management and improvement of wetland sites in South Carolina. Ralph Klawitter, the project leader, has prepared a project analysis to guide the forest and land management research in the swamps and bays of the coastal plain.

The following selected items of accomplishment illustrate our progress in older lines of research during the past year.

ARTIFICIAL REGENERATION

Forest tree planting in the South has reached one million acres a year and is still increasing. This program requires tremendous quantities of seed and planting stock, and heavy expenditures of money and manpower. The increase in area planted has been matched by the increased demand for better methods of producing seed and planting stock, preparing planting sites, and planting

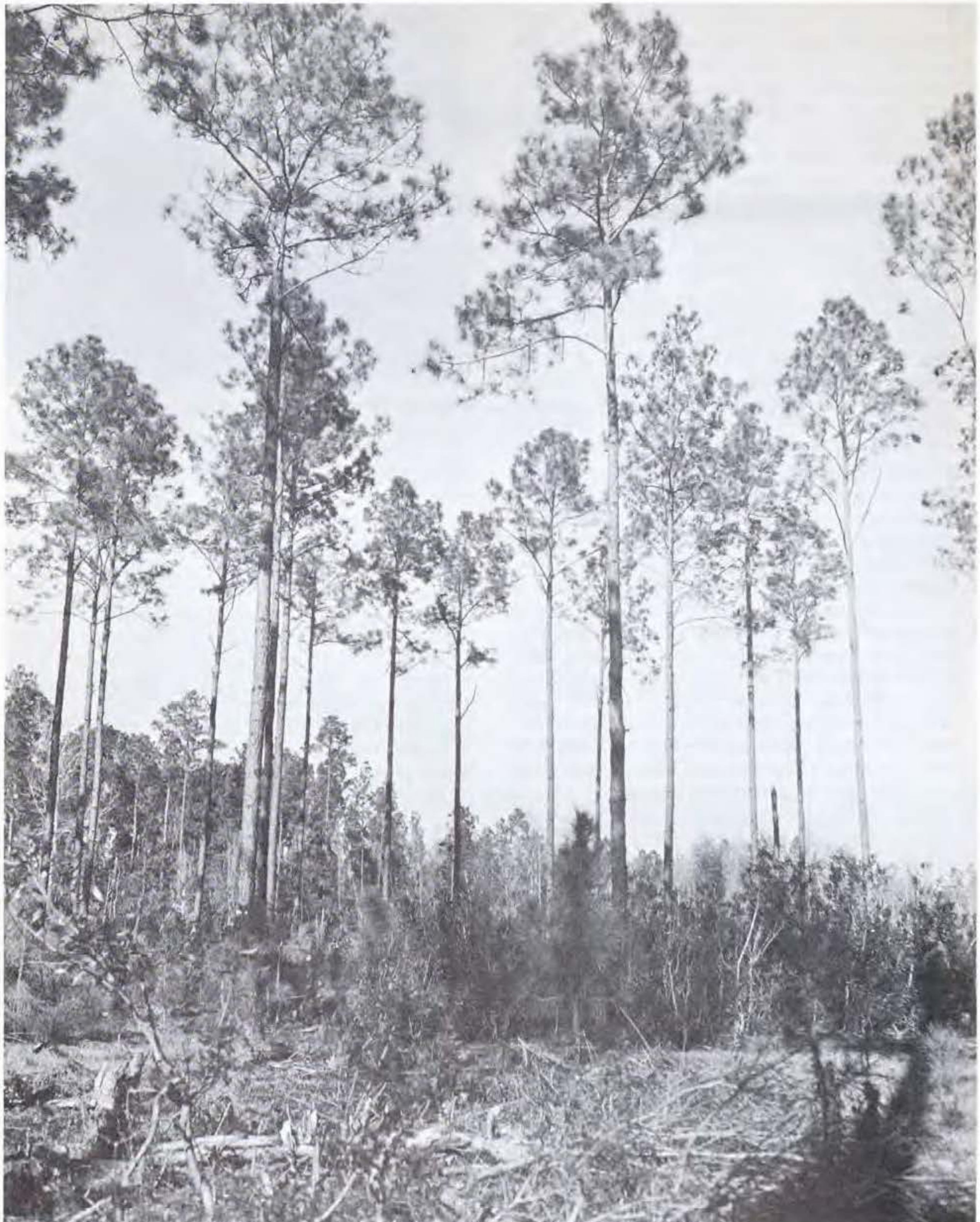


Figure 45.—In 1953 all but the 33 best trees per acre were cut out of a 21-year-old slash pine stand to create a seed-production area. The remaining trees were 26-years old, averaged 14 inches in diameter, and averaged 77 feet in height in 1958.

trees or seed. While the bulk of the seed still comes from regular timber-producing stands and plantations, much of the seed in the future may come from seed-production areas and seed orchards. The main criterion of success in these stands will be the amount of good seed produced per acre per year.

Cone and Seed Production in a Slash Pine Stand

Because cone counts in pine are reasonably good indicators of the size of the seed crop, this relationship has been used in forecasts. While cone counts are useful and have been reliable over large areas, the technique can give poor estimates in a single stand. A 21-year-old natural slash pine stand near Olustee, Florida, was thinned in the fall of 1953 to establish a demonstration seed-production area (fig. 45). Total cone and seed production were measured on 10 trees beginning in 1956 — the first year that the effect of release on cone production could be expected. The 3-year cone and seed production was:

Year	*Cones* (*Bushels*)	*Seed* (*Pounds*)
1956	13.5	4.9
1957	13.9	17.2
1958	14.0	9.3

These variations in the cone-seed ratios in a seed-production area may be the results of insects, disease, or simply inadequate pollination in the poor years. Efforts are now being made to control insect and disease pests of cones and seeds, and it may be that studies designed to improve pollination will offer equal promise in insuring consistently high yields of seed.

Seed Testing

While most seed losses are caused by pests or climate long before the cones are collected, some of the most expensive losses occur in the nurseries when seeds fail to germinate. Both loblolly and slash pine seed may exhibit a dormancy that cannot be predicted on the basis of either appearance or geographic source. Paired germination tests of stratified and nonstratified samples at the regional Seed Testing Laboratory have confirmed the value of such tests prior to treatment of the entire lot of seed (table 8).

Table 8.—Effect of stratification upon the germination of loblolly and slash pine seed

Species and year tested	Seed lots tested	Effect of stratification		
		Benefitted	Injured	Unaffected
	Number	Percent		
Slash pine:				
1956	26	15	35	50
1957	41	15	66	19
Average		15	54	31
Loblolly pine:				
1956	67	48	7	45
1957	74	65	9	26
Average		57	8	35

The most efficient use of seed requires a decision based upon individual lot characteristics. This decision can be made satisfactorily only after comparative tests of stratified and unstratified seed.

Planting Pines in the Carolina Sandhills

"Planting Pines in the Carolina Sandhills" by Robert D. Shipman, Station Paper 96, was published in 1958. This paper represents 4 years of intensive research by this Station, the South Carolina State Commission of Forestry, the Savannah River Project of the Atomic Energy Commission, the School of Forestry of North Carolina State College, the North Carolina State Department of Conservation and Development, and the Westvaco Experimental Forest of the West Virginia Pulp and Paper Company.

The most urgent problem in the Sandhills is survival — how to bring the land into timber production at a reasonable cost. After 4 years we have some of the answers, many of them partial, but with helpful leads. Good examples of the answers are the prescriptions for planting slash and longleaf on old-field sites (table 9).

The scrub oak sites in the Sandhills are among the most difficult planting chances, and a great deal of research effort was spent in developing effective and economical methods of site preparation. One method recommended is to clear, plow, and drag the area

completely and then allow 6 months for soil stabilization before planting. An alternative is to plow furrows 6 to 8 feet apart, and if it is a 2-step operation, allow a minimum of 30 days for soil stabilization. In a 1-step operation the trees are planted without delay (fig. 46).

Cottonwood Plantations

The fast growth of cottonwood has stimulated interest in its use in the conversion of low-quality stands in the stream bottoms of the Georgia Piedmont (fig. 47). One small plantation, planted in 1956 on the Oconee

Table 9.—Prescription planting on old-field sites

Longleaf Pine — Sandhills Sites

	Grade 1 Expected Survival Unfurrowed*	*Grade 1* Expected Survival Furrowed***	*Grade 2* Expected Survival Unfurrowed*	*Grade 2* Expected Survival Furrowed***
All sandy soils; deep sands, loamy sands, sandy loams.	40-45%	70-75%	30%	50%
Spacing (feet).	6 x 5	6 x 8	6 x 4	6 x 6

*Grade 1, ¼" plus at root collar; Grade 2, 3/16-¼" at root collar. Root length at least 5" and well developed lateral roots.
**Seat bottom of bud on top of loose soil raised by planting shoe to avoid silting over bud.

Spacing and number per acre:

6 x 4. 1815	6 x 7. 1037
6 x 5. 1452	6 x 8. 907
6 x 6. 1210	6 x 9. 807

Slash Pine — Sandhills Sites

	Grade 1 Expected Survival Unfurrowed*	*Grade 1 Expected Survival Furrowed*	*Grade 2* Expected Survival Unfurrowed*	*Grade 2 Expected Survival Furrowed*	*Grade 3* Expected Survival Unfurrowed*	*Grade 3 Expected Survival Furrowed*	*Grade 3 Expected Survival Furrowed & Planted Deep***
Deep Sands.	60%	80%	50%	70%	30%	50%	65%
Normal Spacing (Feet).	6 x 7	6 x 9	6 x 6	6 x 8	6 x 4	6 x 6	6 x 8
Loamy Sands.	65%	85%	55%	75%	30%	60%	75%
Normal Spacing (Feet).	6 x 8	6 x 9½	6 x 6	6 x 9	6 x 4	6 x 7	6 x 8½
Sandy Loam	70%	90%	60%	80%	45%	65%	80%
Normal Spacing (Feet).	6 x 8	6 x 10	6 x 7	6 x 9	6 x 5	6 x 8	6 x 9

*Grade 1 specification: Top 6-14", stem diameter 3/16" at ground level (root collar).
*Grade 2 specification: Top 6-12", stem diameter ⅛-3/16" ground level (root collar), all secondary needles.
*Grade 3 specification: Top 3-8", stem diameter 1/16-⅛" ground level (root collar), at least 5 bundles of secondary (long) needles.

Root length at least 5" for all grades, and well developed lateral root system.

Keep roots moist at all times with soupy mud or wet moss and covered with wet burlap. Do not let stand in water.

**If grade 3 (small) seedlings are planted deep in furrows—so just the bud is above ground line—survival is increased by at least 15-30%. Planting bar or machine must go deep enough to avoid U-rooting.

Spacing and number per acre:

6 x 4. 1815	6 x 7. 1037
6 x 5. 1452	6 x 8. 907
6 x 6. 1210	6 x 9. 807

River bottom near Athens, Georgia, has been quite successful. In the fall of 1956 the survival was 88 percent and the mean height was 7 feet (fig. 48). Now, at the end of the third growing season, survival is 66 percent and the mean height is 19 feet (fig. 49).

A severe freeze in February 1958 split the bark at ground line on some trees and they began to die during the growing season (fig. 50). Two fungi, *Dothichiza populea* and *Cytospora chrysosperma*, were found in the damaged areas, but the infections and mortality losses were confined to the freeze-damaged trees.

Photo by West Virginia Pulp and Paper Co.

Figure 46.—One-step method of partial scrub oak eradication and planting. Slash pine planted in deep furrows by HD-9 tractor and a modified Mathis plow in tandem with a tree planting machine.

Figure 47.—A cottonwood in the Oconee River bottom near Watson Springs, Georgia. At 43 years this tree is 32 inches in diameter and has $3\frac{1}{2}$ logs to a fork.

Figure 48.—Cottonwood plantation during midseason of the first year.

Figure 49.—Several trees in the 1956 cottonwood planting exceeded 30 feet in height by the end of the third year.

Figure 50.—Freeze-damaged tree dying during June of the third year.

Rooting Cottonwood Cuttings

Cottonwood is an easily rooted species; yet little has been known of the time rooting begins or the relation of top growth to root growth. Several studies with green ash, yellow-poplar, and sweetgum had shown that the development of the crown was not indicative of root growth. A small study at the Athens-Macon Research Center now suggests that cottonwood rooting begins in early April and that the first sign of leaf development does indicate that rooting is under way (fig. 51). The larger cuttings produce more roots than do the smaller cuttings, and crown development generally follows the same pattern (fig. 52).

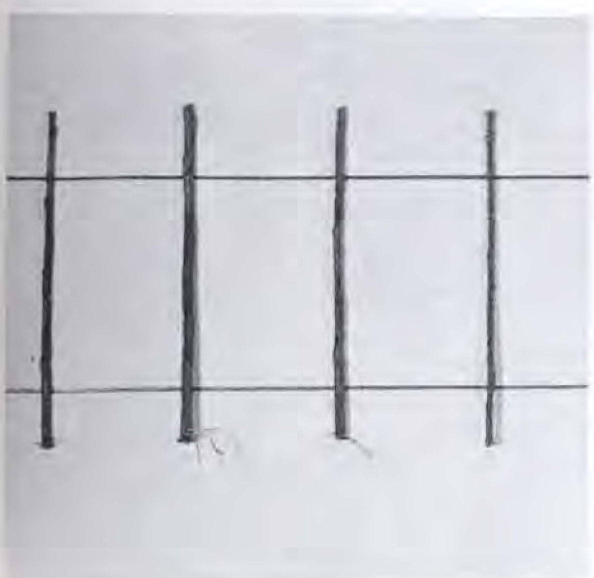


Figure 51.—The first roots originate in the basal callus. Buds are beginning to swell.

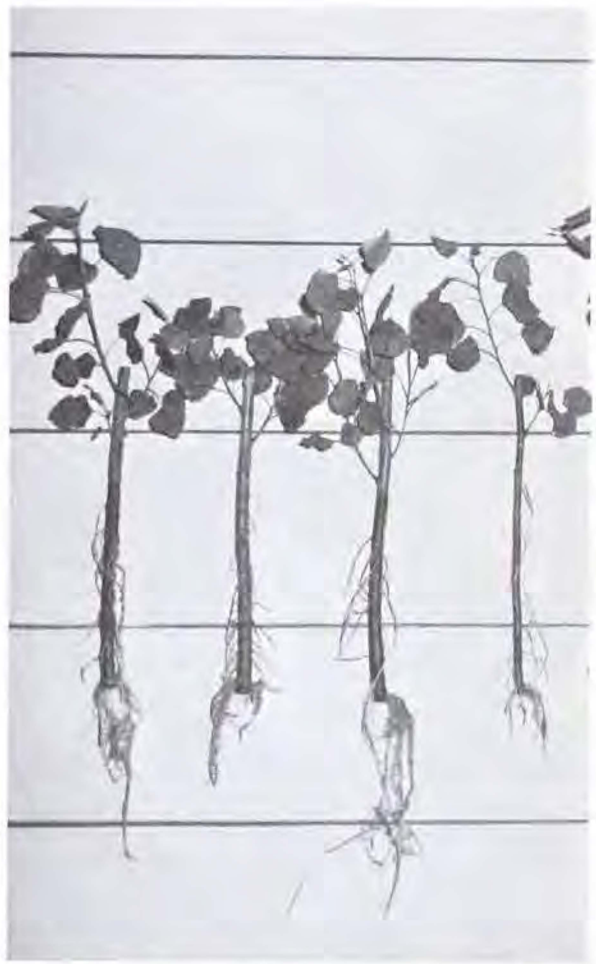


Figure 52.—Both roots and crowns are well developed on most cuttings. The cuttings with poor roots also have poor crowns.

Figure 53.—A released tree, showing the size of opening that relieved the tree from competition and brought about a substantial increase in cone crops.

NATURAL REGENERATION

Most foresters realize that planned natural seeding as well as planting is needed to reverse the present trend setting so strongly toward conversion of pine to low-grade hardwoods. Hardwood stands on pine sites can be converted to pine only by planting, but a high proportion of the pine area harvested each year must be reproduced naturally. This successful natural regeneration will require proper treatment to insure adequate pine seed production, to prepare the seedbed, and to control competing vegetation.

Loblolly Pine in the Coastal Plain

The proper treatments needed for successful natural regeneration of loblolly pine in the coastal plain have been tested and the recommendations are available. The U. S. Department of Agriculture Production Research Report No. 13, "Natural Regeneration of Loblolly Pine in the South Atlantic Coastal Plain," by Karl F. Wenger and Kenneth B. Trousdell, was published in January 1958. This report is an excellent example of the results of carefully planned and well-sustained research.

Ten years ago natural regeneration of loblolly pine was the number-one forest management research problem in the coastal plain. A planned attack on the problem began in 1946 with the summarizing and testing of earlier findings and the designing of new studies to bridge the gaps. Some basic studies investigated the periodicity of seed production; others related seed production to tree characteristics such as age, size, and past fruitfulness. Relating seed production to environment and treatment resulted in specific recommendations for the timing and degree of effective seed tree release (fig. 53). Matching the requirements for germination and initial establishment with the effects of logging and site preparation produced the prescriptions for coordinating the seed supply with the seedbed (table 10).

While the techniques recommended in this report cannot be considered as absolute and final, they are well proven and have changed the picture so that natural regeneration is no longer classed as a major research problem in the coastal plain. With this accomplishment behind them our Franklin and Charleston Research Centers have shifted their programs more to the problems of managing young loblolly pine stands.

Table 10.—Approximate minimum number of loblolly pine seed trees per acre needed to attain the specified stocking of reproduction in the first year after tractor logging [1]

Desired reproduction (percent of mil-acres stocked)	Seed trees per acre when diameter at breast height in inches is-- 8	10	12	14	16	18	20
	- - - - - - -	- -	Number	- -	- -	- -	- -
GOOD SEED YEAR							
40	43	17	9	5	4	3	3
60		37	19	11	7	5	3
75		67	35	20	13	9	6
90			70	41	25	17	12
MEDIOCRE SEED YEAR							
40		38	18	10	6	4	3
60		82	38	21	13	9	6
75			69	39	24	16	11
90				79	49	33	23
POOR SEED YEAR							
40			67	32	19	12	8
60				69	40	25	18
75					73	47	32
90							65

1/ The numbers of trees shown are those required to attain the specified stocking of reproduction on the logged area as a whole, rather than on a single seedbed condition. To determine the number of seed trees needed on areas where burning or disking has been done in addition to logging, multiply the tabular figures by the following factors: logged and burned--2/3, disked and logged--1/3.

Not less than three trees per acre should be left under any conditions, since wider spacing might prevent adequate pollination and reduce seed production.

Loblolly Pine in the Piedmont

The methods of natural regeneration that have been so effective in the coastal plain may need some adaptation in the Piedmont because of lower seed production there. Seed-trap records from 1952 to 1956 on the Hitchiti Experimental Forest near Macon, Georgia, show adequate seed production in only 2 of the 5 years (table 11). Similar records taken on the Santee Experimental Forest near Charleston, South Carolina, show consistently high annual yields of seed.

Many loblolly pine stands in the South Carolina coastal plain probably could be regenerated without residual seed trees if

Table 11.—Loblolly pine seed production in the Georgia Piedmont and the South Carolina Coastal Plain

Seed year	Georgia Piedmont			South Carolina Coastal Plain	
	Uncut stand 55 years old 1/	Seed-tree stand 60 years old 1/	Shelterwood stand 65 years old 1/	Uncut stand 50 years old 1/	Improvement-cut stand 50 years old 1/
	Thousands of sound seed per acre				
1952	139	73	304	101	164
1953	(2/)	9	7	240	320
1954	2	6	13	361	405
1955	214	184	445	696	542
1956	2	1	9	113	98

1/ Stand age in 1952.
2/ Less than 500 seeds per acre.

harvested after seedfall. The lower and more erratic seed production in the Piedmont may make it advisable to maintain a good residual seed source until the area is adequately stocked with seedlings.

STAND IMPROVEMENT

The phenomenal expansion of tree planting in the Southeast tends to overshadow the equally important increase in timber stand improvement work. Thousands of acres of timber are growing faster and are producing higher quality timber following treatment. Often the costs of these treatments must be regarded as long-term investments.

Prescribed Burning Can Pay Its Way

An exception to this rule turned up on the Santee Experimental Forest. Periodic winter burns were prescribed for a loblolly pine stand to maintain control of a hardwood understory in order to simplify natural regeneration of the pine in the late 1960's. An unexpected benefit was realized in 1957, when improvement cuts were made in the burned stand and the adjacent unburned check stand. The reduction in the number of hardwood stems 2 inches and larger in diameter after burning made logging easier and cheaper (table 12). Cash values of the reduced logging costs were $2.29 per thousand board-feet and $1.50 per cord when local rates for equipment and labor were used. These values can be considered as potential stumpage returns and are in addition to other such tangible benefits as reduced marking and protection costs (fig. 54).

Bud Pruning Slash Pine

Bud pruning has been tested on most of the important pine species and has usually given poor results. Slash pine is no exception; bud pruning seriously reduces both diameter and height growth (table 13).

These results are from a slash pine bud pruning study on the George Walton Experimental Forest near Cordele, Georgia. The trees were planted in 1948 and first pruned in 1950. The selected trees were pruned 3 to 4 times each year until pruning heights reached 17 feet. The bottom whorls that were left on half of the pruned trees were alive and vigorous in 1955. By 1958 most of the branches were dead, although on some trees they have developed into extremely large branches (fig. 55). Many of the pruned trees have crooked boles or forks. The combination of poor growth and poor form is more than enough to make bud pruning unprofitable and not recommended in slash pine.

Figure 54.—Two adjacent units after the second improvement cut in a 50-year-old loblolly pine stand: Left, Area 1, one year after third prescribed winter burn, is easy to work in. Right, Area 2 has had no prescribed burning and the heavy understory slows down logging and related forestry activity.

Table 12.—Equipment and man-hours to log burned and unburned stands of loblolly pine

Area	Sawtimber		Pulpwood	
	Equipment	Labor	Equipment	Labor
	- - - Hours per M board feet 1/ - - -		- - - Hours per cord - - -	
Unburned stand	0.81	3.1	0.77	5.7
Burned stand	.59	2.3	.59	4.7
Percent reduction	27	26	23	18

1/ Scribner Decimal C. log rule.

Table 13.—Diameter and height of bud pruned and unpruned slash pine

Plantation spacing (feet)	Unpruned		Pruned except for bottom whorl		All laterals pruned	
	D.b.h.	Height	D.b.h.	Height	D.b.h.	Height
	Inches	Feet	Inches	Feet	Inches	Feet
DECEMBER 1955						
6x6	4.1	23	3.5	22	2.9	22
12x12	5.5	24	4.0	21	3.0	21
DECEMBER 1958						
6x6	5.2	35	4.1	30	3.3	30
12x12	7.0	37	5.2	32	3.7	28

Figure 55.—The bottom whorl of branches on this 10-year-old slash pine, bud pruned in 1950, was still alive and vigorous in 1958. Bud pruning slash pine has proved worthless.

Timber Stand Improvement in the Appalachians

Timber stand improvement in the Appalachians is complicated by the varied mixture of species, tree sizes, and timber quality to be found in any one stand. Because timber quality rather than species or size is the chief criterion for desirability, we must use the more expensive single-tree treatments. Since the response to treatment varies by species and tree size, the treatments must be tailored accordingly.

Recommendations for the control of competing trees and shrubs (table 14) are the results of a study testing 11 treatments on six species and species groups on the Bent Creek Experimental Forest. No one treatment is effective on all species over all size groups. Of the species tested, red maple and rhododendron are the most difficult to control.

Table 14.—Treatments recommended for each species and size group

Species	Size	Treatment
Oak	Sapling	Ammate crystals on stumps, 1 tablespoon per 2 inches of diameter.
Oak	Poletimber	Ammate crystals in cups, 1 tablespoon per cup; 1 cup per 2 inches of diameter. Or 2,4,5-T in oil in ax-frills, 8 lbs. acid equivalent per hundred gallons.
Oak	Sawtimber	Any good girdling treatment; silvicide not necessary.
Hickory	Sapling	2,4,5-T in oil on stumps, 20 lbs. acid equivalent per hundred gallons. Or Ammate crystals, 1 tablespoon per 2 inches of diameter.
Hickory	Poletimber	2,4,5-T in ax-frills, 8 lbs. acid equivalent per hundred gallons.
Hickory	Sawtimber	Ax-girdles (frill or notch); silvicide not necessary.
Red maple	Sapling	Basal spray, 2,4,5-T basal spray, 20 lbs. acid equivalent per hundred gallons.
Red maple	Poletimber	No treatment tested was satisfactory.
Sourwood	Sapling	Ammate crystals on stumps, 1 tablespoon per 2 inches of diameter.
Sourwood	Poletimber	Ammate crystals in cups, 1 tablespoon per cup; 1 cup per 2 inches of diameter.
Rhododendron	--	2,4,5-T in oil on stumps, 20 lbs. acid equivalent per hundred gallons.
Laurel	--	2,4,5-T in oil on stumps, 20 lbs. acid equivalent per hundred gallons. Or basal spray.

SILVICS

The 1958 additions of personnel and program shifts were heavily weighted toward silvical research. Many of the study results, such as new site indices and yield tables, can be used immediately by field foresters. The results of the more fundamental studies may have no practical application now, but they do supply a solid foundation for applied research in the future. The research of Dr. Barnes is a good example; one of the end results of his work will be increased seed production, yet his current studies are limited to the investigation of metabolic compounds and processes involved in the physiology of flowering. Complete understanding of the physiology of flowering will take a long time; yet this knowledge must be available before we can exert any real control over seed production. The less basic but equally important soils-site studies will yield usable information in a much shorter time.

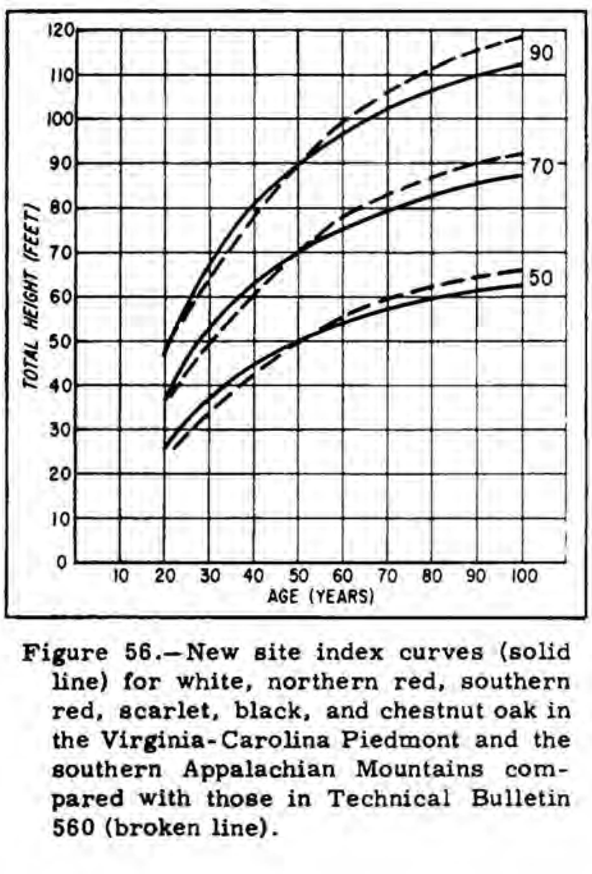


Figure 56.—New site index curves (solid line) for white, northern red, southern red, scarlet, black, and chestnut oak in the Virginia-Carolina Piedmont and the southern Appalachian Mountains compared with those in Technical Bulletin 560 (broken line).

Site Indices for Oak

The height-age curves for oak in U. S. Department of Agriculture Technical Bulletin 560 have been used throughout the eastern United States for over 20 years. The curves were based upon 404 plots scattered from Georgia to Michigan and from Missouri to Michigan, and have been quite satisfactory. The recent soil-site studies in the Virginia-Carolina Piedmont and in the Southern Appalachian Mountains have supplied a total of 697 oak plots that give more precise data for this area. New curves for white, northern red, southern red, scarlet, black, and chestnut oak were prepared, using these data. Data were analyzed separately by species and then combined, as the slope coefficients showed no significant differences. These new curves (fig. 56) are quite close to those in Technical Bulletin 560. Site index estimated from the new curves is a few feet lower for ages under 50 years, and a few feet higher for ages over 50 years. Since the differences are small and the new indices are limited to only a portion of the area sampled for the old indices, any speculation as to the significance of these differences would not be worth while. The new indices should be used for the Virginia-Carolina Piedmont and for the Southern Appalachian Mountains. The Technical Bulletin 560 indices should be used for the other areas.

Soils-Site Studies

Soils-site studies are a major activity at many of the research centers. Soil-site indices and yield tables for both volume and weight of plantation-grown slash pine will be published in 1959. The soils-site relationships for some of the important hardwood species in the Carolina Piedmont are being analyzed and the results will soon be available. The Athens-Macon Research Center has expanded its soil-site work to include the mountains of north Georgia (fig. 57) as well as the Georgia Piedmont. The Asheville Research Center and the Charlottesville, Virginia, unit will also have substantial studies under way in the Piedmont and mountains during 1959. These studies will be supplemented by the regional investigations of the effects of stand density, age, and site on growth and yields.

Figure 57.—Soil sample collected in north Georgia by the Athens-Macon soils-site crew will be sent to the soils laboratory at Union for analysis.

Stand Density Studies

Preliminary 5-year results of the regional study of the growing space requirements of loblolly pine were published in our Station Paper 97. These partial results indicate that a low level of stand density is best for a poor site but a good site will support a relatively high stand density throughout the rotation. The failure to show optimum densities may have been due to the limited range of densities sampled. Additional plots were thinned at the beginning of the second 5-year period and the chances of determining optimum levels should be much better at the end of the current period.

A similar study in natural slash pine stands will soon be ready for its first remeasurement. Both studies will be supplemented by new studies in slash and loblolly pine plantations. The slash pine plantation study will be a joint project of the Cordele and Lake City Research Centers. The loblolly pine plantation study will be handled by the Athens-Macon Research Center. Both studies will be greatly strengthened by industry's participation in the installation and maintenance of plots on company lands.

The Asheville Research Center is preparing a work plan for a stand density study for mixed hardwoods in the Piedmont and mountains. This study will be more complex than the pine studies because of the effect of site on species composition and the interaction of site and species composition on growth and timber quality.

Influence of Topography on Species Composition

Observations made on the Hitchiti Experimental Forest near Macon, Georgia, show that the rate of hardwood invasion in the Georgia Piedmont is strongly influenced by aspect, degree of slope, and position on the slope (fig. 58). A dense loblolly pine overstory retarded the growth of the hardwood understory but had little effect on the occurrence of the hardwoods.

Three general conclusions can be drawn from the correlation of the influence of topography on the rate at which hardwoods invade loblolly pine in the lower Piedmont.

1. Loblolly pine can usually be perpetuated without hardwood control on all gentle upper slopes and on moderate upper slopes with a southerwestern exposure.
2. Loblolly pine can be perpetuated if hardwood control measures are practiced on steep upper slopes with a southwestern exposure, moderate upper slopes with a northeastern exposure, and on all moderate lower slopes.
3. Loblolly pine will be difficult and perhaps unprofitable to perpetuate because of hardwood competition on steep upper slopes with a northeastern exposure, all steep lower slopes, and in bottoms.

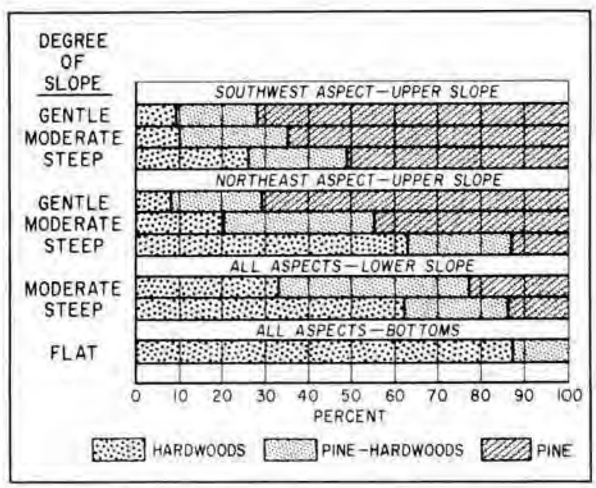


Figure 58.—Distribution of loblolly pine understory types in relation to aspect, degree of slope, and position on slope at the Hitchiti Experimental Forest in Georgia.

FARM WOODLAND MANAGEMENT

Forestry progress is lagging badly on small ownerships in the South; the real gains have been made by wood-using industries, large landowners, and public agencies. Most farm woodlands and other small holdings produce only a small fraction of the wood and income they could yield under reasonable management. Reliable costs and returns information and on-the-ground demonstrations of good forest management are needed to encourage small owners to intensify their woodland management. The farm woodland demonstration-test on the George Walton Experimental Forest, near Cordele, Georgia, meets these needs for its immediate area.

Costs and Returns

Annual cash returns as high as $9.00 per acre may be obtained from managed woodlots in the Georgia Coastal Plain (table 15). When management began in 1950, many of the second-growth and almost all of the old-growth trees were of poor form and were not desirable growing stock. Most of the volume was slash pine, with some longleaf and loblolly pine. An improvement cut in 1950 removed most of the poor trees. The returns were not included in table 15, because this cut is considered as preparatory to management.

Naval stores operations on the woodlot are carried on as an integral part of management. Trees to be harvested are marked 4 to 5 years in advance of the cut, worked for 4 years, and then harvested in the regular cyclic cut. The first naval stores operation, installed in 1952, utilized improved techniques of bark chipping, acid stimulation, and removable tins on 553 faces.

The second cyclic cut was made in 1956 and included 1,495 board-feet of sawtimber, and 2.49 cords of pulpwood per acre. In 1957, 532 faces on trees designated to be removed in the third cutting cycle were cupped.

Table 15 is a complete listing of costs and returns on the woodlot, including costs of cultural operations, such as control of undesirable hardwoods and the periodic pruning of future crop trees when called for. Net income for the first 7 years the stand was under management was $63.37 per acre, or $9.05 per acre per year. Sawtimber volume has grown during this period at an annual rate of 342 board-feet per acre. Increases in the per-acre growth are expected as stocking is built up. Pulpwood volumes have been reduced, but a rapid increase is expected in the near future as seedlings and saplings reach pulpwood size. While we were achieving this income, proper management has produced healthy, fast-growing stands so that even larger returns may be expected in the future.

FOREST GENETICS AND TREE IMPROVEMENT

If a good job of forest management is to be done now, the genetic quality of the trees must be considered when seed is collected, when seedlings are purchased, when improvement cuts are made, or when the final crop is harvested. Such consideration will be effective if based on the findings of a well-rounded forest genetics research program. Our present program at Macon, Georgia, is directed toward selection and breeding of pine for improved growth, form, disease resistance, and wood quality (fig. 59). Studies of racial and within-stand variation are under way and progeny-testing techniques are being improved. At Lake City, Florida, the project in developing high gum-yielding strains of slash pine is being continued, and seed orchards to produce seed of improved strains have been established. The original program has been broadened to include selection and breeding slash pine for traits other than gum yields. The other research centers also participate in racial studies of yellow-poplar, red oak, hemlock, and the southern pines.

Certified Seed

Prompt acceptance of the findings of tree improvement research has resulted in the establishment of certification standards for forest tree seed in Georgia. By 1960 it will be possible for a seed producer to market seed bearing the blue tag "CERTIFIED SEED" of the Georgia Crop Improvement Association. Under the Georgia Standards, seed will be certified as Class I, II, or III. Class I will be reserved for seed produced from progeny-tested clones in seed orchards or from controlled pollinations of progeny-tested elite trees. Class II includes seed from seed orchards prior to completion of progeny tests

and open-pollinated seed from progeny-tested elite trees. Class III seed are from seed production areas or from open-pollinated plus trees. An isolation strip is required for all production except where controlled pollination is used.

Eventually, Class III seed will be dropped from the list, but it is presently the largest potential source of certified seed. A number of years will elapse before quantity production of Class I seed can begin, because of the time involved in progeny testing. These progeny tests must be maintained until the Georgia Crop Improvement Association has accepted the data presented on them and is satisfied as to the genetic quality of the seed.

Table 15.—Farm woodland costs and returns, 1950 to 1956, George Walton Experimental Forest

Date	Management action	Income per acre	Cost per acre
		Dollars	Dollars
1952	Hardwood control, 0.49 man-hour per acre at $0.80 per man-hour	--	0.39
1952	Pruning, 0.28 man-hour per acre at $0.80 per man-hour	--	.22
1952	Cost of naval stores materials	--	2.49
1952	Naval stores operation, 0.485 bbl. per acre at $23.58 per bbl.; 7.89 man-hours per acre at $0.80 per man-hour	11.44	6.31
1953	Naval stores operation, 0.472 bbl. per acre at $23.58 per bbl.; 6.74 man-hours per acre at $0.80 per man-hour	11.13	5.39
1954	Naval stores operation, 0.465 bbl. per acre at $24.40 per bbl.; 6.61 man-hours per acre at $0.80 per man-hour	11.35	5.29
1955	Naval stores operation, 0.400 bbl. per acre at $26.10 per bbl.; 6.76 man-hours per acre at $0.80 per man-hour	10.44	5.41
1956	Timber marking and scaling, 0.80 man-hour per acre at $1.85 per man-hour	--	1.48
1956	Sawtimber harvest, 1.495 M board feet per acre at $27.60 per M	41.26	--
1956	Pulpwood harvest, 2.49 cords per acre at $4.60 per cord	11.45	--
1950-1956	Taxes at $0.17 per acre per year x 7 years	--	1.19
1950-1956	Protection at $0.79 per acre per year x 7 years	--	5.53
	Totals	97.07	33.70
	Net return	63.37	
	Annual net return	9.05	

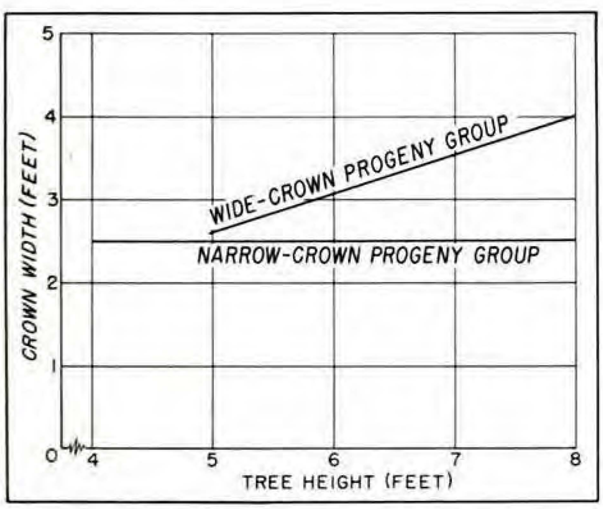


Figure 59.—Tests in Georgia show that crown width and branch length are strongly inherited. Upper left, typical wide-crown seedling (4 years old) from wide-crown mother tree. Upper right, typical narrow-crown seedling (4 years old) from narrow-crown mother tree. Graph illustrates tendency of the wide-crown trees to get wider as they grow taller, whereas the narrow-crown progeny stay narrow. By selection, which is the simplest, quickest method of tree improvement, we have also isolated strains of trees that inherently produce high or low gum yield, heavy or light wood, and long or short fibers.

Slash Pine Seed Source Trial

Early results of local seed source trials lead to the belief that stands at the extreme north and extreme south portion of the range of slash pine are inherently slower growing than those in the central portion.

Fourteen lots of seed collected in various portions of the range of slash pine were sown at Lake City in the spring of 1954. Three of the lots were from separate localities near the north extremities of the range of slash pine, two in central Florida, and the remaining nine lots were from the interior portion of the species range in south Georgia and north Florida. Seedlings grown from them were outplanted in five localities in the winter of 1954-55. Average total heights (as of the winter of 1957-58) of progenies from within the three broad "zones" outlined are summarized in table 16.

Progenies from the central portion of the range of slash pine averaged tallest at all planting sites. Although the superiority of these sources was small when planted in Georgia and south Florida, it was more substantial in north Florida. Progenies generally grew fastest to date at the Effingham County, Georgia, site and poorest at the Lake County, Florida, site, while differences among the remaining three sites were small.

Seed-source effects upon survival were rather small, except that survival percents for the two central Florida lots were lowest at all plantations. Planting-site effects on survival were rather large, on the other hand, with survival the greatest at the two north Florida sites.

Definite conclusions cannot, of course, be drawn from these tests until the progenies are older. Final results will be important because of the rather common practice at present of collecting seed from south-central Georgia for planting in north Florida. The early results indicate that it may be wise to avoid collecting seed from the extreme northerly portion of the species range for planting in south Georgia and north Florida.

Table 16.—Mean total heights and survival of slash pine progenies from different sources planted the winter of 1954-55 in five localities. Data taken the winter of 1957-58

Seed source locality	Planting sites				
	South Georgia		North Florida		South Florida
	Dooley County	Effingham County	Liberty County	Baker County	Lake County
	Mean total height--feet				
South central Georgia 1/	3.2	4.8	2.8	2.8	2.1
Extreme south and southeast Georgia and north Florida 2/	3.5	4.9	3.3	3.2	2.2
Central Florida 3/	3.4	4.5	2.9	2.6	2.1
	Survival--percent				
South central Georgia 1/	51.7	52.9	72.8	81.9	51.8
Extreme south and southeast Georgia and north Florida 2/	49.5	44.8	73.5	81.0	49.8
Central Florida 3/	33.2	40.2	65.6	62.3	45.2

1/ Seed sources were from each of the following Georgia counties: Calhoun, Laurens, and Dooley.

2/ Seed sources were from each of the following counties: Baker, Taylor, Calhoun, and Nassau, Florida; and Emanuel, Effingham, Brooks-Loundes, Jeff Davis, and McIntosh, Georgia.

3/ Seed sources were from each of the following Florida counties: Citrus and Volusia.

Air-Layering Slash Pine

A growth-regulator screening study conducted on air-layering of slash pine during the 1958 growing season indicates that naphthaleneacetamide may be a suitable, but not preferable, substitute for indolebutyric acid (table 17). Gibberellic acid gave very poor results and trichlorophenoxyacetic acid was a complete failure. Three of the chemicals were tested at concentrations of 1 percent and 2 percent, and the fourth, gibberellic acid, at 0.1 percent and 0.2 percent.

Air-layering was done on ten trees each from 20-year, 30-year, and 40-year age classes. Two air-layers were made in each tree for each chemical-concentration combination. The air-layers were made between July 24 and August 6 and were removed 10 weeks after installation.

Propagation Techniques Applicable to Longleaf Pine

Although appreciable literature exists concerning the vegetative propagation of loblolly, shortleaf, and slash pines, there is little published information regarding the vegetative propagation of longleaf. Longleaf pine has been propagated at Lake City, Florida, by cuttings, air-layering, and by bottle-grafting. While the percentages of successful takes with these three methods have been low on initial trials, it is important to know that longleaf pine can be propagated by the same techniques used with other southern pine species. With further tests, propagation techniques can probably be refined to give a greater degree of success.

A Truck-Mounted Ladder for Collecting Cones

The job of tree climbing will become increasingly important as tree-breeding programs are enlarged and as seed-production areas and orchards begin producing sizeable seed crops. In some instances trees from selected areas have been felled to facilitate cone collection, but in seed orchards established from clonal stock of superior parentage the trees will be too valuable to cut. To gather cones from these standing trees, the collector must either climb the tree and punch the cones off while working within the crown or gather cones by some other means from a vantage point outside of the crown.

As an aid to collectors, a ladder mount for a fire-fighting extension ladder has been designed (fig. 60). It is completely operable by one man. The mount, used on a ½-ton pickup truck, supports a 40- to 50-foot heavy-duty aluminum ladder. For taller trees the ladder rig can be used to gain access to the lower crown preparatory to climbing higher within the tree crown.

Figure 60.—Truck-mounted ladder in travelling position.

Table 17.—Comparison of slash pine air-layer-rooting response to three plant growth regulators in three tree age-classes

Tree age-class (years)	Indolebutyric acid concentration		Naphthaleneacetamide concentration		Gibberellic acid concentration	
	1 percent	2 percent	1 percent	2 percent	0.1 percent	0.2 percent
	Percent of air-layers rooted					
20	30	10	30	10	5	5
30	10	10	15	10	0	0
40	10	15	10	0	0	0

NAVAL STORES

Naval stores research at Lake City, Florida, includes both fundamental and applied studies. Past investigations of the role of chemical treatment in stimulating resin flow have led to the development and general acceptance of bark chipping with acid stimulation. These investigations have shown that the acid does not stimulate resin production but merely facilitates the outflow. Any real gains in resin production within the tree will depend upon the development of superior strains of high gum-yielding trees and by increasing gum yields through silvicultural practices. High-yielding strains are being developed by selection and breeding, and demonstration "gum orchards" are being established. Field tests of the effects of fertilization, cover crops, and irrigation on the growth and gum yields of both average- and high-yielding trees have been installed on the Olustee Experimental Forest.

While the methods and schedules of chipping have no effect upon the ability of a tree to produce gum, they do have a very real effect on the costs of gum extraction. A good deal of preliminary work on intensive chipping methods has been done, and pilot plant tests were carried on to determine the practicality of these techniques for commercial operations. This information and other information as to the effects of tree size and crown length on gum yields have been put to use in the Naval Stores Conservation Program.

Equipment development for efficient gum extraction has been another important phase of applied research. These improved tools have made it easier to gain public acceptance of the more conservative new extraction methods. While further improvements in hand tool design are possible, the next major "break through" will probably be the mechanization of the extraction process.

PUBLICATIONS

by

MEMBERS OF THE STAFF, INCLUDING COOPERATORS

Calendar Year 1958

Anderson, W. C.
A "MODIFIED DOYLE" RULE-OF-THUMB FOR ESTIMATING BOARD-FEET IN SMALL LOGS. Southeast. Forest Expt. Sta. Res. Note 116.
(Simple rule-of-thumb more accurate than Doyle rule in estimating board-foot volume of logs less than 18 inches in diameter.)

Black, P. E., and Clark, P. M.
TIMBER, WATER, AND STAMP CREEK. Southeast. Forest Expt. Sta., illus.
(Careful road layout and logging to minimize damage was well demonstrated on the Stamp Creek sale, Chattahoochee National Forest, Georgia.)

Bois, P. J., and Haigh, A. H., Jr.
THE RISING IMPORTANCE OF AGGREGATED WOOD PRODUCTS. Soc. Amer. Foresters Proc. 1957: 120-122.
(Discusses methods of fabrication and economics of producing various aggregated wood products from material hitherto considered waste.)

Boyce, J. S., Jr.
NEEDLE CAST OF SOUTHERN PINES. U. S. Dept. Agr. Forest Pest Leaflet 28, 4 pp., illus.
(A popular leaflet that describes the symptoms, causes, and control for pine needle blights, with emphasis on brown spot and *Hypoderma lethale*.)

Boyce, J. S., Jr.
TWIG BLIGHT OF EASTERN WHITE PINE CAUSED BY MONOCHAETIA PINICOLA. Phytopathology 48(9): 516-517.
(A small canker that results in twig blighting has been seen in several localities, and was proven to be caused by a little-known fungus.)

Boyce, J. S., Jr., and Stegall, W. A., Jr.
OBSERVATIONS ON OAK WILT DETECTION IN TENNESSEE IN 1957. Plant Dis. Rptr. 42(5): 707-709.
(Annual aerial surveys together with roadside observations and revisits to old wilt centers over a 5-year period located about 25 percent of the centers active during this period, as judged during a 100-percent ground survey in Green County, Tennessee.)

Brender, E. V.
A 10-YEAR RECORD OF PINE SEED PRODUCTION ON THE HITCHITI EXPERIMENTAL FOREST. Jour. Forestry 56: 408-410.
(Loblolly pine seed production lower in Piedmont than in Coastal Plain. Shelterwood stands produced more seed than seed tree stands, adequately stocked mature stands, or open-grown immature stands.)

Bryan, M. B.
FOREST STATISTICS FOR THE MOUNTAIN REGION OF VIRGINIA. Southeast. Forest Expt. Sta. Forest Survey Release 52, 52 pp., illus.
(Statistics on forest area, timber volume, growth, and cut, with trends in forest area and timber volume between the first and second surveys.)

Bryan, W. C.
DEFECT IN PIEDMONT HARDWOODS. Southeast. Forest Expt. Sta. Res. Note 115.
(Epicormic and adventitious branching led the causes of lowered quality of all species, followed by insect holes, sweep and crook, disease defects, birdpeck, and fire scars.)

Byram, G. M.
SOME BASIC THERMAL PROCESSES CONTROLLING THE EFFECTS OF FIRE ON LIVING VEGETATION. Southeast. Forest Expt. Sta. Res. Note 114.
(Quantity of heat required to raise temperature of living vegetation up to lethal temperature is directly proportional to difference between this temperature and initial vegetation temperature.)

Campbell, R. A.
DOES THE BUTT LOG DEFINE TREE GRADES? *In* Hardwood Sawlog-Grading Symposium Proc. 1957. Pub. jointly by Ill. Agr. Expt. Sta. and Purdue Agr. Expt. Sta., pp. 68-73.
(Brief discussion of history and theory of butt log tree grading. Examples of results given.)

Clements, R. W.
GUM NAVAL STORES. Forest Farmer Manual XVIII(7): 113-117.
(Describes and illustrates modern naval stores production methods and use of naval stores tools.)

Clements, R. W.
LONGER LIFE FOR NEW METAL CUPS ON ACID-TREATED TREES. Naval Stores Rev. 68(7): 6. Also in AT-FA Jour. 21(1): 14-15.
(Early installation of new metal cups permits accumulation of enough rainwater to minimize acid damage.)

Clements, R. W.
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(Describes and illustrates techniques of using new hammer tool.)

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(Reports tests of coverage and vegetation penetration of slurry from TBM aerial tanker.)

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(An illustrated history and description of research program at Olustee Experimental Forest.)

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SAND PINE REGENERATION IN FLORIDA. Soc. Amer. Foresters Proc. 1957: 71-72.
(Sand pine will regenerate naturally if stands are cut, tractor-logged, and skidded during May to December.)

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WARRING ON FIRE WITH CHEMICALS. Forest Farmer XVII(8): 4-5.
(Initial trials with sodium calcium borate show promise for the use of chemical fire retardants in the South.)

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VOLUME DETERMINATIONS FOR SECOND-GROWTH SLASH AND LONGLEAF PINE IN NORTHEAST FLORIDA. Southeast. Forest Expt. Sta. Paper 92, 11 pp.
(Presents cubic foot, board-foot—both Scribner and International ¼-inch—and topwood tables for slash and longleaf pine.)

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(Site indices of 10 species correlated; when site index of one species is known it is possible to estimate site indices for other species.)

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NEW CROP TREES—REFORESTATION BY NATURAL MEANS. Forest Farmer Manual XVIII(7): 71-72.
(Continuous use of forest land by harvesting methods that will assure regeneration through silvicultural management or by planting.)

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Froelich, R. C.
TIMBER CULL IN VIRGINIA AND THE CAROLINAS. Southeast. Forest Expt. Sta. Res. Note 121.
(Summary of timber cull studies giving relative importance and average board-foot and cubic-foot volume losses resulting from several types of cull by tree species group.)

Gruschow, G. F., and Trousdell, K. B.
INCIDENCE OF HEART ROT IN MATURE LOBLOLLY PINE IN COASTAL NORTH CAROLINA. Jour. Forestry 56: 220-221.
(Slow growth as well as old age contributes to susceptibility of loblolly pine to heart rot.)

Halls, L. K., and Ripley, T. H.
THE FUTURE OF WILDLIFE IN THE SOUTHERN FOREST. Forest Farmer XVIII(3): 5, 14-16.
(Survey of the status of forest-game habitat research in the South indicates significant accomplishments, but emphasizes need for much new research.)

Harper, V. L., Briegleb, P. A., and Pechanec, J. F.
WHERE WE ARE NOW IN FOREST RESEARCH—A REPORT ON 10 YEARS OF PROGRESS. Forest Farmer XVIII(2): 6-9, 28-29.
(Reviews major areas of forest research in South over last 10 years. Also indicates future needs and role research will play in supplying answers.)

Hepting, G. H.
FOREST DISEASES—A GROWING PROBLEM. The Unit 74: 26.
(Diseases have greater impact on southern timber growth than any other destructive agent. Discusses the present status of damage, control, and research for the South's main diseases.)

Hepting, G. H.
OUR CURRENT RESEARCH NEEDS: FOREST TREE DISEASES. Forest Farmer XVIII(2): 14.
(Cites special need for fundamental research on diseases, expanded work on main forest and nursery diseases, a greater effort in such new fields as nematodes, seed diseases, et al., and better disease surveys.)

Hepting, G. H.
SOUTHERN CONE RUST. U. S. Dept. Agr. Forest Pest Leaflet 27, 4 pp., illus.
(Account of the occurrence of cone rust, species affected, damage caused, life history, and control possibilities.)

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(Investigations are expected to show comparative water-use requirements of pine vs. hardwood stands. Early studies suggest white pine provides satisfactory watershed protection and regulation of water yields.)

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THE EFFECT OF FUMIGATION ON THE RELATIVE ABUNDANCE OF SOIL MICROORGANISMS. (Abs.) Assoc. South. Agr. Workers Proc. 1958: 222-223.
(Soil population counts made at intervals after fumigation showed Vapam and methyl bromide selective in action against fungi, actinomycetes, and bacteria, while these organisms responded similarly to steam.)

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AN IDEA IN TRUCK-MOUNTED LADDERS. Jour. Forestry 56: 852-853, illus.
(Description of truck-mounted ladder for use in seed orchards, seed production areas, and in tree breeding programs.)

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(Longleaf pine can be vegetatively propagated by cuttings, grafting, and air layers with same techniques used for other southern pines.)

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(Indicates relative fire occurrence and describes probable fire behavior according to 5 classes of burning index.)

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(Thirteen separate state reports containing tables and graphs analyzing forest fires and fire danger.)

Kowal, R. J.
FOREST ENTOMOLOGY IN SOUTHERN UNITED STATES. Tenth Internatl. Cong. Ent. Proc. 1956: 399-406.
(Historical review of research in forest entomology in southern United States, review of current problems and research, and statement on what is foreseen in future.)

Kowal, R. J.
MEETING THE PROBLEM OF TREE-KILLING INSECTS. Forest Farmer Manual XVIII(7): 38-40.
(Report of progress in improving detection and reporting of insect outbreaks and in research on control of important southern forest pests.)

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THE PRESENT STATUS OF FOREST INSECTS. The Unit 74: 24-25.
(Discussion of primary forest insect problems, particularly as they affect the pulp and paper industry, and progress and needs in forest insect surveys and research.)

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BEETLES IN YOUR PINES? Southeast. Forest Expt. Sta., 29 pp., illus.
(Recognition, life history, prevention of damage, and control of Ips, black turpentine, and southern pine beetles.)

Kraus, J. F.
TWENTY NON-INDIGENOUS PINES GROW IN NORTH FLORIDA. Silvae Genetica 7, Heft 2.41-80, p. 69.
(Lists three Asiatic, five European, and twelve North American pines growing in the arboretum on the Olustee Experimental Forest.)

Langdon, O. G.
CONE AND SEED SIZE OF SOUTH FLORIDA SLASH PINE AND THEIR EFFECTS ON SEEDLING SIZE AND SURVIVAL. Jour. Forestry 56: 122-127.
(Large seed from small cones gave best survival. Large- and medium-size seedlings survived better than small seedlings.)

Langdon, O. G.
EARLY TRENDS IN A SLASH PINE SEED SOURCE STUDY IN SOUTH FLORIDA. Southeast. Forest Expt. Sta. Res. Note 123.
(Third-year results indicate slash pine from center of slash pine range grew better in south Florida than seedlings from either northern or southern fringes of range.)

Langdon, O. G.
SILVICAL CHARACTERISTICS OF BALDCYPRESS. Southeast. Forest Expt. Sta. Paper 94, 24 pp., illus.
(Extent and climate of botanical range, edaphic and physiographic site conditions, reproductive and growth habits, ecology, plant and animal pests, and response to management.)

Langdon, O. G.
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(Cubic-foot and board-foot tables—both Scribner and International ¼-inch—for South Florida slash pine.)

Lehman, J. W.
PRODUCTS FROM HICKORY BOLTS. Southeast. Forest Expt. Sta. Hickory Task Force Rpt. 6, 20 pp., illus.
(Presents information on size, quality, and grade requirements of hickory bolts in use today. Specifications for bolt products and comments on manufacturing methods.)

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(Discussion of survey and control activities.)

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(Production of round pulpwood and pulp chips from wood residues by pine and hardwood species groups, by state; also production of roundwood by county.)

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(Rate of photosynthesis reached a peak in September; respiration rate for loblolly pine increased throughout the year. White pine respiration rates increased as plants grew, dropped when growth ceased, and increased again during winter.)

McLintock, T. F.
HARDPAN AND ROOT PENETRATION IN THE SPRUCE-FIR FORESTS. Soc. Amer. Foresters Proc. 1957: 65-66.
(Nonindurated sand-silt hardpans underlying spruce-fir forests of Maine are practically impervious to water and tree roots.)

Martindale, D. L.
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Matthews, F. R., and McLintock, T. F.
EFFECTS OF FUNGICIDES ON POLLEN GERMINATION OF SLASH AND LONGLEAF PINE. Southeast. Forest Expt. Sta. Res. Note 122.
(At concentrations used in sprays for cone rust, and also at lower concentrations, captan and Basi-cop depressed pollen germination, Puratized prevented it, and ferbam increased it.)

Merkel, E. P.
DIORYCTRIA CONE MOTH ATTACK AS RELATED TO CONE RUST OF SLASH PINE IN NORTH FLORIDA. Jour. Forestry 56: 651.
(Rust-infected cones appear indirectly responsible for additional heavy losses in second-year cones by providing favorable breeding place for cone moth larvae.)

Metz, L. J.
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(Location, history, and research program of Calhoun Experimental Forest—a program aimed at rehabilitation of depleted Piedmont soils.)

Metz, L. J.
MOISTURE HELD IN PINE LITTER. Jour. Forestry 56: 36.
(Pine litter in a 12-year loblolly plantation had a low water-holding capacity, but served importantly in reducing raindrop impact and overland flow.)

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FOREST FIRE RESEARCH NEEDS IN THE SOUTH. Jour. Forestry 56: 399-403.
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(Factors affecting success of vegetative propagation and details of methods—grafting, rooting, and air layering—that seem to offer most promise with American species.)

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ROLE OF CHEMICAL TREATMENT IN STIMULATING RESIN FLOW. Forest Sci. 4(4): 296-306.
(Available evidence suggests sulphuric acid treatment does not increase rate of oleoresin synthesis, but serves chiefly to facilitate flow of oleoresin from resin ducts.)

Page, R. H.
RELATIVE EFFICIENCY OF FOUR STACKING METHODS IN AIR-SEASONING SOUTHERN PINE LUMBER. Forest Utilization Serv. Tech. Paper 1, 19 pp., illus.
(Evaluates rate of drying, uniformity of drying, and loss from seasoning degrade of four common methods of air-seasoning pine lumber in Georgia.)

Page, R. H.
WOOD PRESERVATION IN HOME CONSTRUCTION. Forest Utilization Serv. Release 19.
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(Discusses importance of integrating natural resources, such as water, soil, forests, and wildlife.)

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(Extent and climate of botanical range, edaphic and physiographic site conditions, reproductive and growth habits, ecology, plant and animal pests, and response to management.)

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EFFECT OF SOIL AMENDMENTS ON GROWTH OF SHORTLEAF PINE. Jour. Forestry 56: 215-216.
(Nitrogenous fertilizers increased growth of pole-size trees, in some cases doubling it, but the cost outweighed the advantages.)

Rummell, R. S.
CATTLE STOCKING AND HERBAGE YIELD ON BURNED FLATWOODS RANGES. Southeast. Forest Expt. Sta. Res. Note 118.
(Native herbage yield increased from 66 to 2,225 pounds per acre, 21 days to 9 months after fresh February burn on ungrazed range, south Florida.)

Shipman, R. D.
EFFECT OF SEASON OF TREATMENT ON GIRDLING AND CHEMICAL CONTROL OF OAK AND SWEETGUM. Jour. Forestry 56: 33-35.
(Growing-season treatments gave a quicker kill than dormant-season treatments, and 2,4,5-T in frills is faster and controls sprouting better than girdling.)

Shipman, R. D.
PLANTING PINE IN THE CAROLINA SANDHILLS. Southeast. Forest Expt. Sta. Paper 96, 43 pp., illus.
(Keys to successful longleaf planting are proper site preparation, allowing soil to become stabilized, and planting high quality seedlings.)

Sluder, E. R.
CONTROL OF CULL TREES AND WEED SPECIES IN HARDWOOD STANDS. Southeast. Forest Expt. Sta. Paper 95, 13 pp., illus.
(No single treatment is recommended for all species; treatments vary by species and by tree size.)

Sluder, E. R.
MOUNTAIN FARM WOODLAND GRAZING DOESN'T PAY. Southeast. Forest Expt. Sta. Res. Note 119. Also in Farmers Federation News XXVIII(11): 24.
(Cattle gain weight slowly, or may even lose weight in the woods; they damage soil, destroy seedlings, and reduce growth rates of timber.)

Smith, R. H.
CONTROL OF THE TURPENTINE BEETLE IN NAVAL STORES STANDS BY SPRAYING ATTACKED TREES WITH BENZENE HEXACHLORIDE. Jour. Forestry 56: 190-194, illus.
(A properly executed and maintained program of spraying attacked trees with 1-percent BHC in fuel oil will markedly reduce activity of black turpentine beetle.)

Smith, W. R.
EXISTING SOUTHERN FOREST AND WOOD RESEARCH FACILITIES. APA Tech. Paper 58, p. 29.
(Speech on wood research in the Southeast, especially in the pulp and paper industry, and comments on research coordination.)

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(Discusses treating of wood to form wood plastics by resin impregnation, by compression, or by remolding component parts after separation.)

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(Highlights of the Station's research results.)

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(Insect and disease conditions from fall of 1957 to April 1958.)

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(Insect and disease conditions during summer of 1958.)

Speers, C. F.
THE BALSAM WOOLLY APHID IN THE SOUTHEAST. Jour. Forestry 56: 515-516.
(First report of discovery of an infestation of this newly introduced serious pest of true firs in the Southeast.)

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(Protection of seedlings, costs of application of three concentrations, and three treatments compared.)

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(Several hundred thousand acres of hardwoods defoliated in tristate area; life history and control of insect reported.)

Speers, C. F.
PALES WEEVIL RAPIDLY BECOMING SERIOUS PEST OF PINE REPRODUCTION IN THE SOUTH. Jour. Forestry 56: 723-726, illus.
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Swofford, T. F.
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(Need for stratification must be determined by comparative tests of stratified and unstratified seed before treating loblolly and slash pine seed.)

Wenger, K. F.
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(Preliminary results indicate that a low level of stand density is optimum for growth on a poor site; a good site will support a relatively high stand density.)

Wenger, K. F., and Trousdell, K. B.
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(Ecological behavior, seed production, requirements for germination and initial establishment, methods of natural regeneration, and treatment of reproduction stands of loblolly pine.)

Wright, J. W., Bingham, R. T., and Dorman, K. W.
GENETIC VARIATION WITHIN GEOGRAPHIC ECOTYPES OF FOREST TREES AND ITS ROLE IN TREE IMPROVEMENT. Jour. Forestry 56: 803-808.
(A critical review of philosophy and results to date of work in individual tree variation and its utilization in establishing seed orchards.)

Zak, Bratislav, and Campbell, W. A.
SUSCEPTIBILITY OF SOUTHERN PINES AND OTHER SPECIES TO THE LITTLELEAF PATHOGEN IN LIQUID CULTURE. Forest Sci. 4(2): 156-161.
(*Phytophthora cinnamomi* attacked shortleaf more readily than loblolly roots, heavily attacked roots of slash and longleaf pine, lightly attacked Arizona cypress and redbud, and failed to attack sweetgum.)

Zobel, B. J., Barber, John, Brown, C. L., and Perry, T. O.
SEED ORCHARDS—THEIR CONCEPT AND MANAGEMENT. Jour. Forestry 56: 815-825.
(Summary of pertinent information on American seed orchards: their objectives, establishment, and care.)

Addenda

The following item was omitted from the Station's 1956 Bibliography:

Bennett, F. A., and Brender, E. V.
A PROJECT ANALYSIS FOR RESEARCH IN PLANTATION ESTABLISHMENT AND MANAGEMENT IN GEORGIA. Southeast. Forest Expt. Sta. and Ga. Forest Res. Council, 94 pp.
(Summarizes available information, discusses major problems, and lists by priorities research studies needed to solve problem of plantation management in Georgia.)

The following items were omitted from the Station's 1957 Bibliography:

Halls, L. K., Hale, O. M., and Knox, F. M.
SEASONAL VARIATION IN GRAZING USE, NUTRITIVE CONTENT, AND DIGESTIBILITY OF WIREGRASS FORAGE. Ga. Agr. Expt. Sta. Tech. Bul. (n.s.) 11, 28 pp., illus.
(South Georgia native forage showed crude protein adequate (if near minimum requirements) from spring to summer, but unsatisfactory in winter. Need for seasonal protein-energy supplements indicated.)

Hepting, G. H.
A RUST ON VIRGINIA PINE AND BUCKLEYA. Mycologia 49(6): 896-899.
(Reports a new stem rust of Virginia pine that works much like blister rust. It has its alternate stage on the shrub *Buckleya distichophylla*.)

Miller, J. H., Giddens, J. E., and Foster, A. A.
A SURVEY OF THE FUNGI OF FOREST AND CULTIVATED SOILS OF GEORGIA. Mycologia 49(6): 779-808.
(An account of the fungi active in forest and other soils, including nurseries, with descriptions of many new species.)